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COMPARISON OF MOISTURE RELATED PROPERTIES OF PET/CV BLENDED NONWOVEN FABRICS

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Abstract: *Moisture related properties of polyester (PET) / viscose (CV) nonwoven fabrics were investigated in this research. Four different nonwoven fabrics, PCV0, PCV1, PCV2 and PCV3, having different viscose proportion namely 0%, 30%, 50% and 70% were selected, respectively. The manufacturing techniques and fabric thickness values were kept the same for the comparison of tested fabrics. Moisture absorption, vertical water wicking, air and water vapor permeability tests were carried out and also moisture transmission performance of the blended nonwoven fabrics was examined in order to evaluate the effects of fiber ratios on moisture related properties of the blended fabrics. It was determined that higher viscose content in the blended fabrics result in higher vertical water vicking performance of the fabric. The moisture content of the fabrics also increased with increasing viscose proportion. This is most probably because of the high moisture absorption capacity of the viscose fibers. The wetting time and wetting radius results are in reverse ratio with the viscose proportion of the fabrics in moisture management test. It can be also stated that permeability properties depend not only viscose content but also fabric structural parameters.*

Key words: *nonwoven, moisture, permeability, viscose fiber, polyethylene teraphtalate fiber*

1. INTRODUCTION

The demands from textile fabrics are not only for style and durability but also for psychological comfort by means of moisture absorption and transmission performance. Fiber type is one of the main factors affecting the clothing comfort. To improve comfort properties and to impart functional performance such as soft hand and easy care of textile fabrics, blending of fibers is very popular in textile industry. Fiber blends have been widely used to combine the superior properties of different types of fibers. Blending of fibers can enhance the functional features and extend the end-uses of the fabrics. It is taken into account that the fibers having different material types (man-made or natural, protein or cellulose based fibers), different moisture absorbing capability (hydrophilic or hydrophobic) and/or mechanical performance are selected when blending fibers.

In the related scientific literature, number of studies was carried out to investigate the effects of structural parameters (especially hydrophilic fiber proportion %) on different performance properties of nonwoven fabrics made of blended fibers. Das et al. stated that blending has a critical role in moisture related comfort properties [1]. They found out that viscose fiber positively influenced the water vapor permeability and absorbency with increasing the hydrophilicity of polyester (PET) / viscose (CV) fabrics. Mahish et al. revealed that the increase in bamboo fiber proportion increases water wicking and UV protection ability of bamboo/PET knitted fabrics [2]. It is also pointed out that polyester fabrics with higher bamboo content will be more suitable to wear in summer. Das et al. investigated the effects of structural parameters such as yarn count, twist and polyester content on moisture related properties of PET blended fabrics [1]. Moreover, some other papers focused on finishing processes to improve properties and to impart functionalities of blended fabrics. İbrahim et al. focused on the incorporation of different additives to improve UV protecting performance of cotton/wool and CV/wool blended fabrics [3]. In another research paper, İbrahim et al. experimented several finishing methods using different chemical agents to enhance multifunctional properties of polyester/cellulose blended fabrics [4]. CV/PET fabrics were chemically and physically treated to examine the usability as CO and CO_2 capturing filters by Elnagar et al. Hydrophilic fibers especially cellulose based fibers absorb higher number of water molecules and have high hygroscopic moisture content as compared with synthetic fibers [5]. Cellulose based fibers exhibit high absorbency, breathability and comfort for wear [3,4]. PET fibers are more resistant to microbial and bacterial attack, stronger and wrinkle resistant. Despite their advantageous properties, their highly hydrophobic nature results in lack of comfort for wear. Blending CV with PET gives them combined properties which encourage their use more than each separate fabric [5].

The aim of this research is to study how hydrophilic fibers affect moisture absorption and transmission properties of blended nonwoven fabrics. For this purpose, PET and CV fibers were selected, which were commonly and widely used in textile industry, due to their different moisture absorbing natures. Four types of nonwoven fabrics were utilized having different viscose proportion (0%, 30%, 50% and 70%). Fabric thickness and manufacturing techniques were kept the same to compare effects of fabric mass and viscose proportion on tested properties of the fabric samples. Air and water vapor permeability, vertical water wicking, moisture content and moisture management tests were carried out to evaluate the influence of CV fibers and fiber structural parameters on moisture related properties of PET/CV nonwovens.

2. EXPERIMENTAL

2.1 Materials

In this experimental study, four types of PET/CV nonwoven fabrics having different PET and CV ratios were utilized. Fabric mass per unit area (g/m^2) and fabric thickness (mm) of the fabric samples were measured in accordance with ASTM D 751-06 and ISO 5084:1996, respectively. Fabric thickness of the test specimens were measured by using James Heal RxB Cloth Thickness tester under constant pressure. The sample codes and some technical details of the fabric samples are given in Table 1.

Table 1: *Technical details of the fabric samples*

Sample Code	Material	Mass per area (g/m^2)	Fabric thickness (mm)	Manufacturing technique
PCV0	100% PET	31.7	0.3	Spunlace
PCV1	30/70% CV/ PET	44.1	0.3	Spunlace
PCV2	50/50% CV/ PET	47.3	0.3	Spunlace
PCV3	70/30% CV/ PET	48.0	0.3	Spunlace

2.2 Methods

All fabric samples were in preconditioned in standard atmosphere of 65±2% relative humidity and 20±2ºC at least for 24h before all testing.

Air permeability of the fabric samples were tested by using TexTest FX3300 Air Permeability Tester at a pressure of 200Pa in accordance with ISO 9237. Ten measurements for each test samples were performed to check for repeatability.

Water vapor permeability of the fabric samples was measured in accordance with BS 7209 using the evaporative dish method or control dish method. Water vapour permeability of the fabric samples was calculated by using equation 1.

$$WVP(g/m^2/24) = 24\,\frac{M}{A\times t} \qquad \textbf{(1)}$$

where WVP, A and t indicate water vapor permeability, the internal area of the dish (m^2) and the time between weighings in h, respectively. And also M indicates the loss in mass.

Vertical wicking performance of the fabric samples were tested in accordance with DIN 53924. The specimens of each fabric samples were prepared in the dimensions of 25mm x 150mm. The specimens were suspended and immersed in 1% w/v $K_2Cr_2O_4$ aqueous solution which is used for tracking the movement of the liquid along the fiber due to its no affinity to man-made fibers. The height reached by the solution was measured and recorded at time intervals of 1min, 5min, 10min, 15min, 20min, 25min and 30min.

Hygroscopic moisture contents of the fabric samples were determined by using the gravimetrical method.

Moisture management capability of the fabric samples were tested by using SDL ATLAS Moisture Management Tester (MMT) according to AATCC test method 195-2009. The tester is equipped with two moisture sensors, upper and lower. This tester measures the liquid moisture transport from upper face to lower face of the test specimens and also wetting time, wetting radius and wetting spreading speed at these two different faces, separately. The top surface of device is simulated the surface in contact with the skin and the bottom surface is simulated exposing to the atmosphere [6].

2. RESULTS AND DISCUSSION

Air and water vapor permeability of the fabric samples were tabulated in Table 2. Nonwoven fabrics are porous structures that can easily allow the transmission energy and also substances [7]. The porosity of these types of fabrics is affected by fabric structural parameters such as fabrics mass and fabric thickness, etc. The absorption, uptake and permeability properties depend on the porosity character of the fabrics. There are noticeable differences between air permeability values of the fabric samples (Table 2). As given in Table 1, the blended fabric samples with changing viscose proportion have same fabric thickness but different fabric mass values. The decrements in air permeability values from PCV0 to PCV3 fabric samples can be explained by systematic increase in fabric mass of the fabric samples.

It is also pointed out from Table 2 that water vapor permeability of the fabric samples changes non-systematically according to the viscose proportion or fabric mass, separately. These differences may be explained the combined effect of these two parameters. Water vapor transmission mechanism of fabrics involves the diffusivity and sorption-desorption of the fabrics which is influenced positively with moisture regain and hygroscopicity of the fabrics, respectively [1, 8]. It is figured out from Table 2 that the greatest increase (8.3%) in water vapor permeability from PCV0 (100% PET) to PCV1 (30/70% CV/PET) can be a result of the viscose proportion although fabric mass increase by 39.1%. The hygroscopic viscose fibers cause higher diffusivity and higher sorption-desorption by absorbing water vapor (humidity) and releasing it to dry air as compared with PET fibers. However, PCV0, PCV2 and PCV3 fabric samples have similar water vapor permeability results. In comparison with PCV0, fabric mass and viscose proportion of PCV2 fabric sample increase by 49.2% and 50% whereas these parameters increase by 51% and 70% for PCV3 fabric sample, respectively. The increase in both two parameters may neutralize their own effects.

Table 2: *Air permeability and water vapor permeability of the fabrics*

Sample Code	Air Permeability ($l/m^2/s$)	Water vapor permeability ($g/m^2/24h$)
PCV0	4623.5±180.5	777.1±14.4
PCV1	3848.5±282.5	841.8±3.90
PCV2	3487.0±133.7	784.5±1.30
PCV3	3093.0±273.2	789.1±34.0

Figure 1 shows the moisture content of the fabric samples which was tested by using gravimetrical method. As clearly understood from Figure 1, the viscose fiber proportion has a great positive effect on moisture content of 100% PET fabric sample (PCV0) as it is expected. Because of highly hydrophilic nature of viscose fiber, the PET/CV blended fabric samples achieved moisture absorption property.

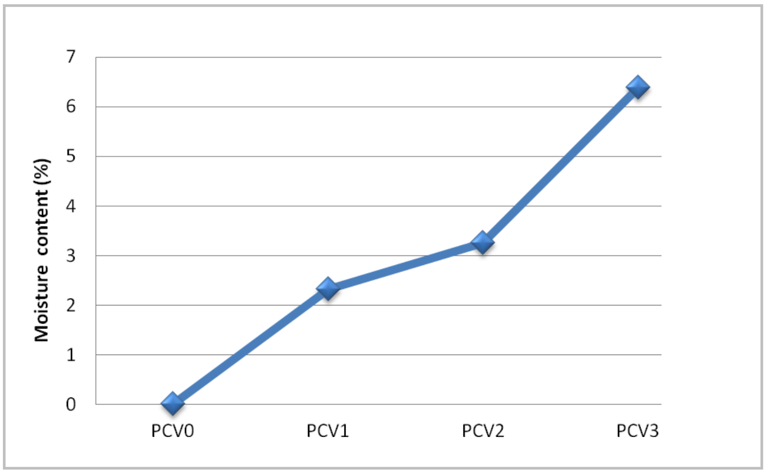

Fig. 1: *Moisture content of the fabric samples*

Representative results presented in Figure 2 that water wicking height increase with increasing proportion of viscose fiber in the fabric samples. No wicking height was observed PCV0 fabric sample in any time interval due to its highly hydrophobic nature. The influence of increasing the proportion of viscose fiber from 30% (PCV1) to 50% (PCV2) on water wicking performance is more evident in cross direction. This finding is not in agreement with previous research by Das et al., 2009 [1]. In this study, this positive contribution on water wicking can be explained by absorption behavior of viscose fibers. Due to their excellent water absorbency based on their hydrophilic character, viscose fibers can easily form hydrogen bonding with water molecules. Close examination of the values in Figure 2, maximum increase in water wicking height was recorded at 0-1min for all types of the fabric samples. Water movement became slower with increasing the time intervals.

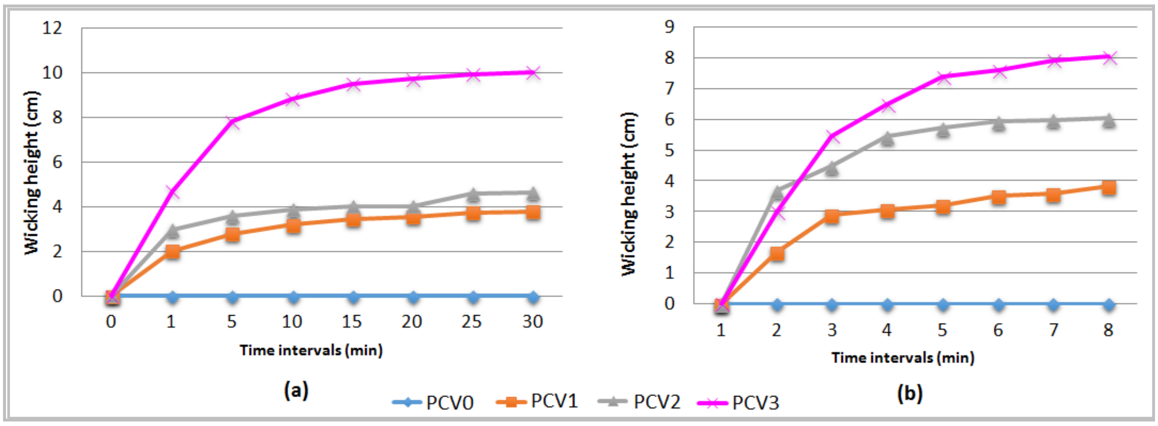

Fig. 2: *Vertical wicking heights of the fabric samples in both directions (a: machine direction, b:cross direction)*

Moisture management mean values of the fabric samples can be seen in Table 3. PCV3 fabric sample has the lowest wetting time at both the bottom and the top as compared with other fabric samples. When the liquid dropped at the top surface of the fabric sample, the liquid absorption occurred immediately, but wetting of top and transportation of the liquid to bottom occurred slowly. This may be due to the high absorbability of viscose proportion of the blended fabric sample. The viscose proportion increased the wetting radius of 100% polyester fabric sample in both top and bottom surfaces. The absorption of liquid by viscose proportion in the blended fabric samples can be responsible for the wetting radius of top surface. Because there is no wetting radius detected at the top of PCV0 fabric sample. But wetting radius values at bottom surfaces are the results of capillary forces [6]. Test results also reveal that overall liquid moisture management capability (OMMC) value is 0 for PCV0 fabric sample which means that 100% polyester fabric used in this study has no ability to transport the liquid moisture. The blended fabrics have higher OMMC values but no general tendency observed according to the viscose proportion. OMMC values exhibit the capacity or ability of the fabrics to transport the sweat from skin to outer surface of the fabrics.

Table 3: *Mean values of moisture management properties of the fabrics*

Sample code	Top wetting time (s)	Bottom wetting time (s)	Top absorption rate (%)	Bottom absorption rate (%)	Top max wetted radius (mm)	Bottom max wetted radius (mm)	OMMC
PCV0	7.44	120.0	54.50	0.00	5.00	0.00	0.00
PCV1	4.05	6.09	28.81	64.81	29.00	29.00	0.60
PCV2	2.59	2.59	62.38	66.82	30.00	30.00	0.45
PCV3	2.13	2.19	61.21	62.50	30.00	28.33	0.44

3. CONCLUSIONS

PET/CV fabrics were examined to study the effect of viscose ratio (0, 30, 50 and 70%) on moisture related properties of the nonwovens. The moisture content and vertical wicking performance of the fabrics increased with increasing viscose fiber ratio. This is due to the highly hydrophilic structure of the viscose. Air permeability is in reverse ratio with fabric thickness as expected. However, water vapour permeability results are affected from both fiber content and fabric unit weight. The fabric sample having the highest viscose content has the lowest wetting time at both the bottom and the top as compared with other fabric samples. When the liquid dropped at the top surface of the fabric sample, the liquid absorption occurred immediately, but wetting of top and transportation of the liquid to bottom occurred slowly. This is due to the high absorbability of the viscose. A geometrical and physical model which considers the moisture related properties of blended nonwoven fabrics can be constructed for future study to predict the thermal comfort properties of nonwovens.

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