STUDY ON THE EFFECT OF POLYESTER/COTTON FIBER RATIO IN TEXTILE FIBERS ON SOME OF THE THERMAL AND MOIST COMFORT PROPERTIES OF INTERLOCK FABRICS

Tho Luu Thi[1,*], Van Hai Nguyen[1], Thanh Nam Pham[1]

DOI: https://doi.org/10.57001/huih5804.2026.140

ABSTRACT

This study evaluates the effect of the polyester/cotton fiber ratio in textile fibers on some of the thermal and moist comfort properties of Interlock fabrics through the use of 04 samples of fabrics with composition ratios: 100% cotton, 65% polyester/35% cotton, 83% polyester/17% cotton, 100% polyester. The fabric samples were prepared and conditioned according to TCVN 1748:2007 (ISO 139:2005), then experimented: Determining the density of the fabric according to TCVN 5794:1994; Determination of yarn ring length according to TCVN 5799:1994 standard; Determination of fabric thickness according to TCVN 5071:2007 (ISO 5084:1996). Fabric samples after determining structural parameters are determined to absorb water according to TCVN 5091:90 standard; determination of capillary capacity (fabric longitudinal absorbency) according to AATCC TM197 standard; determination of air permeability standard TCVN 5092:2009 (ASTM D 737:2004). The results showed: The polyester/cotton fiber ratio has an effect on water absorption, capillary conductivity, and air permeability. Fabrics with a higher percentage of polyester fibers will have poor absorbency and capillary conductivity, but will have higher air permeability.

Keywords: *Knitted fabric, interlock fabric, PE/Cotton composition ratio, water absorption, capillary conductivity, air permeability.*

[1]Faculty of Garment Technology and Fashion Design, Hanoi University of Industry, Vietnam
[*]Email: tholt@haui.edu.vn
Received: 12/3/2026
Revised: 12/5/2026
Accepted: 25/5/2026

1. INTRODUCTION

The Interlock fabric (double-sided fabric on the right) is shaped on a horizontal knitting device with two flat or round needle beds. Organizationally, this structure is established from the bonding of two Rib weaving systems. Specifically, the two needle systems are arranged according to the Rib 1x1 organization, arranged staggered and intertwined; Therefore, textile equipment is required to operate with an even number of ring-forming nests (minimum of two). The looping process is carried out sequentially on each needle bed by two sets of yarn feeders: Polyester yarn (PES - Yarn I) and Cotton yarn (CO - Yarn II) which are fed to the front needle bed and the posterior needle bed respectively (Figure 2). The fiber loops are intertwined and tightly bonded to form an opposite double loop structure. Thanks to the tight locking and internal balance between the ring columns on both sides, the Interlock fabric structure achieves high dimensional stability, thick texture, and completely suppresses the phenomenon of curling and slipping. However, the density of Interlock fabric is usually larger than that of Rib organization with the same parameter, and requires the input fiber material to be of high mechanical strength and quality, leading to an increase in production costs [1].

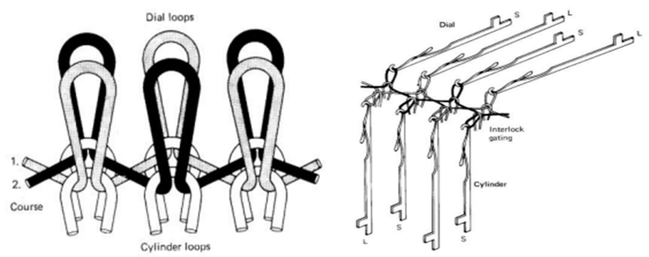


Figure 1. Interlock fabric structure

The physical and mechanical characteristics and thermophysiological comfort of knitted fabrics have been evaluated through domestic and international studies. Surveys on warp knitting (75% PA6/25% Spandex) structures[1] and weft knitting (85% PA/15% Spandex) [2] confirm that weaving organization directly governs moisture transfer kinetics and durability; Specifically, the increase in fabric density is directly proportional to capillary conductivity, post-wash shrinkage, and tensile strength, but inversely proportional to air permeability [1, 2]. Besides, the microclimate of the garment is also determined by the fiber composition and layered architecture. A dedicated three-layer double jersey construction (Micro-fibre Polyester, Micro-fibre Polyester/Polyester/Acrylic blend, Modal) has been proven to optimize water transport rates and vertical absorbency [3]. At the same time, in the Viscose/Cotton mixed fabric system (50/50 ratio), the use of thin viscose fibers reduces air permeability compared to conventional fibers, but still maintains a higher level than the 100% cotton fabric sample [4]. Moreover, the ability to manage moisture is in fact strongly affected by mechanical deformations, as verified by MMT M290 measurements on five commercial T-shirt models (100% cotton, 97% cotton/3% elastane, 95% cotton/5% viscose, 54% cotton/46% polyester) [5]. In the 15% stretched state, the deformation of the pore network size and capillary microstructure between the fibers is activated, thereby promoting liquid perspiration and significantly improving the thermophysiological comfort for the user [5].

In this study, the authors used 04 samples of interlock knitted fabrics with composition ratios: 100% cotton, 65% polyester/35% cotton, 83% polyester/17% cotton, 100% polyester to study the effect of fiber composition on water absorption, capillary conductivity and breathability of interlock knitted fabrics. From there, it contributes to supplementing the experimental database, serving the design process, improving quality and improving customer experience in the process of using products from Interlock horizontal knitted fabrics, selecting the right yarn composition for each specific type of product.

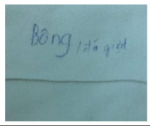
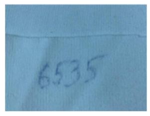
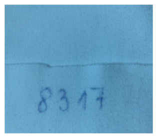
2. MATERIALS AND METHODS

2.1. Materials

The study used 04 types of interlock knitted fabrics with composition ratios: 100% cotton, 65% polyester/35% polyester, 83% polyester/17% cotton, 100% polyester corresponding to 04 fabric samples M1, M2, M3, M4.

The interlock knitting structure was identified as the object of study based on the mechanical and technical characteristics: high dimensional stability, surface uniformity, and resistance to curling and slippage; thereby meeting the technical requirements for high-quality textile and garment products. In order to analyze and evaluate the impact of the ratio of raw material composition on the thermal and moisture comfort characteristics of the material, an experimental model was established with fiber ratios including: 100% cotton, 65% polyester/35% cotton, 83% polyester/17% cotton and 100% polyester.

Table 1. Coding the fabric samples used in the study

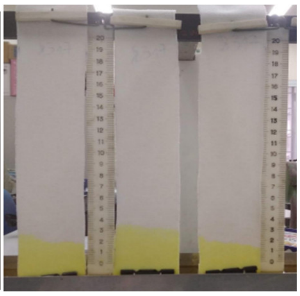
STT	Ingredients	Fiber Index D	Weave	Fabric pattern symbol	Sample
1	100% Cotton	Ne20	Interlock	M1	
2	65% Polyester 35% Cotton			M2	
3	83% Polyester 17% Cotton			M3	
4	100% Polyester			M4	

2.2. Test Design

The experimental design was to evaluate and compare the effect of yarn composition on some of the comfort properties of interlock knitted fabrics. The fabric samples are prepared, the basic parameters are determined, then the absorbency is determined, the capillary conductivity is determined, and the air permeability is determined according to the standard.

a) Temperature-humidity control cabinet and electronic scale

b) Drying cabinet and fabric gripper



c) Capillary Height Measuring Instrument

d) Air permeability measuring machine

Figure 2. Some of the equipment used in the study

2.3. Evaluation Methodology

Table 2. Basic structural parameters of experimental samples

Fabric pattern	Fiber Index D	Yarn loop length (mm)	Fabric density		Thickness (mm)
			Vertical density (number of rows/100mm)	Horizontal density (number of ring columns/100mm)	
M1	Ne20	1.85	112	156	1.31
M2		1.83	117	144	1.26
M3		1.80	120	136	1.25
M4		1.92	112	138	1.32

The evaluation of the effect of fiber composition on certain moisture heat comfort properties of interlock knitted fabrics is carried out through a series of standard methods aimed at evaluating the water absorption, capillary conductivity, and air permeability of knitted fabrics. The process is carried out in detail as follows:

Determination of basic parameters of interlock knitted fabrics: Preparation and conditioning of test samples, determination of yarn loop length (mm), longitudinal density, transverse density (ring rows and columns/10 cm) and fabric thickness (mm) are determined according to TCVN 1748:2007 (ISO 139:2005), TCVN 5799:1994, TCVN 5794:1994 and TCVN 5071:2007 (ISO 5084:1996) respectively in order to control the degree of structural similarity between samples.

Determination of water absorption of fabrics: Fabric samples are determined for water absorption according to TCVN 5091:90 standard.

Determination of fabric capillary conductivity: Fabric samples are determined for capillary conductivity (fabric longitudinal water absorption) according to AATCC TM197 standard.

Determination of fabric breathability: Fabric samples are determined for breathability according to TCVN 5092:2009 (ASTM D 737:2004).

These evaluation methods ensure a comprehensive analysis and evaluation of the effect of yarn ratio on some of the comfort properties of interlock knitted fabrics.

3. RESULTS AND DISCUSSION

3.1. Effect of PE/Cotton Fiber Ratio in Textile Fibers on Water Absorption of Interlock Knitted Fabrics

The water absorption of the test fabric samples is shown in Table 3.

Table 3. Water absorption h of fabric samples (%)

Fabric pattern	Hygroscopicity H (%)			Average (%)
	Model TN1	Model TN2	Model TN3	
M1	22.78	21.08	22.14	22.00
M2	6.70	8.12	6.90	7.24
M3	4.15	5.70	5.53	5.13
M4	2.71	1.86	3.16	2.58

Experimental data from Table 3 show that the sequential decline in water absorption of the fabric sample is directly proportional to the increase in the composition of synthetic fibers, specifically the water absorption level is recorded to be peaked in the M1 sample (100% cotton, 22.00%), decreased in the M2 blended samples (65% polyester/35% cotton, 7.24%), M3 (83% polyester/17% cotton, 5.13%) and reached the minimum level in the M4 model (100% polyester, 2.58%). This variation is explained based on the chemical and physical nature of the surface of the material; in which, the hydrophilic properties of the M1 sample are determined by the cellulose macromolecular structure containing a high density of polar hydroxyl (-OH) functional groups, which facilitates the formation of a sustainable hydrogen bond network with water molecules.

In contrast, the hydrophobic nature of polyester fibers in the M4 sample comes from the highly crystalline polymer structure and the absence of polar functional groups, resulting in severely limited hydration capacity. The inevitable physical and mechanical consequence is that in composite textile structures, when the percentage of polyester fibers is increased, the total number of sites capable of forming hydrogen bonds per unit of fabric area is correspondingly suppressed, thereby confirming a strong inverse correlation between the hydrophobic fiber mixing ratio and the thermal and moist comfort properties of the object data.

3.2. Effect of PE/Cotton Fiber Ratio in Textile Yarn on Capillary Conductivity of Interlock Knitted Fabric

The water absorption of the experimental fabric samples is shown in Figure 3. Experimental data on the fluid transmission kinetics (capillary) of fabrics from Figure 3 demonstrate the inverse variation between the capillary capacity of textile materials and the constituent hydrophobic synthetic fiber content.

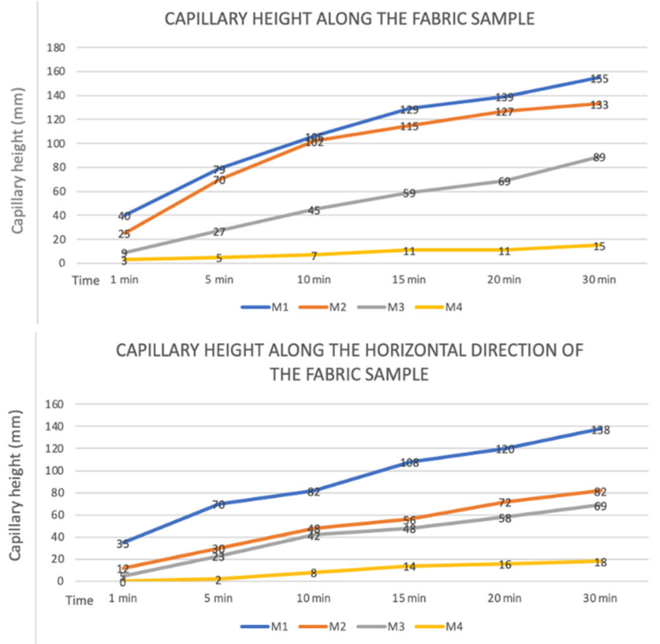


Figure 3. Graph showing capillary height vertically (top) and horizontally (bottom) (mm)

Specifically, after the 30-minute measurement cycle, the capillary height in both vertical and horizontal directions was recorded to reach the maximum level in the M1 sample (100% cotton) with respective values of 155mm and 138mm, then decreased sharply in the M2 mixed samples (65% polyester/35% cotton: 133mm longitudinal, 82mm horizontal), M3 (83% polyester/17% cotton: 89mm longitudinal, 69mm horizontal) and the minimum level in the M4 model (100% polyester: 15mm longitudinal, 18mm horizontal). The physical mechanism of this phenomenon is simultaneously governed by the material surface affinity and the structural anisotropyness of the weave. Chemically-physically, the cellulose structure of cotton fiber contains a high density of polarized hydroxyl (-OH) groups that help reduce the angle of contact with the surface, creating strong capillary pressure inside the microorganic system; In contrast, the hydrophobic, highly crystalline nature of polyester polymers completely suppresses this momentum. At the same time, the pronounced difference in capillary height between the longitudinal and horizontal directions between the hydrophilic patterns (M1, M2, M3) confirms the structural anisotropic character, where the geometric orientation of the capillary network, combined with the density and tension of the longitudinal system, has created a more optimal fluid transport route than the weft system.

Taken together, the increase in the percentage of polyester fibers is directly proportional to the degree to which hydrophilic microorganums are replaced by hydrophobic microorganums, resulting in a comprehensive deterioration in the capillary transmission capacity of the material structure.

3.3. Effect of PE/Cotton Fiber Ratio in Textile Yarn on Air Permeability of Interlock Knitted Fabric

The breathability of the test fabric samples is shown in Figure 4.

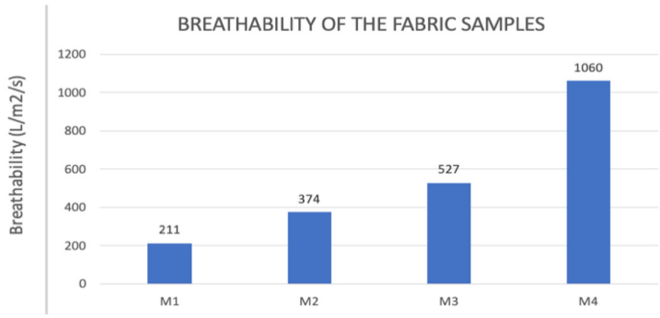


Figure 4. Graph showing the breathability of the fabric sample (L/m^2/s)

The experimental data on the graph represent the air permeability (permeability) characteristics of M1 M2 M3 M4 fabric samples, which are quantified through the volumetric flow of air passed through a unit of material surface area in a unit of time *(L/m²/s)*. In contrast to the fluid capillary transmission mechanism, variation in air inlet flow was noted to be homovariate with the synthetic fiber content in the structure. The minimum permeability level was determined in the M1 (100% cotton) sample with 211 *(L/m^2/s)*, then increased sequentially in the mixed samples, reaching 374 *(L/m^2/s)* in the M2 sample (65% polyester/35% cotton) and 527 *(L/m^2/s)* in the M3 sample (83% polyester/17% cotton), before reaching the maximum threshold of 1060 *(L/m^2/s)* at the M4 model (100% polyester). Significant differences in gas transmission parameters between experimental samples are argued through fibrous morphology and geometric structure porosity. In the M1 model, cotton is essentially a short natural fiber with a high ruffle index; The system of subfilaments protruding from the surface of the filament body constitutes micro-obstructions, filling and shrinking the size of the air capillaries between the fibrous network, thereby increasing aerodynamic resistance. In contrast, polyester synthetic fibers have a smooth surface morphology, uniform fiber structure, and minimize the appearance of surface fibers. The inevitable physical and mechanical consequence is that when the percentage of polyester fibers increases from the M2 to M4 sample, the ruffling coefficient of the structure is correspondingly reduced, and the empty microorganic space between the woven fiber loops is expanded, leading to a sharp decrease in resistance to air flow.

Thereby, the positive correlation between the smooth hydrophobic surface characteristics of the raw material and the air permeability of the textile material structure is clearly affirmed.

4. CONCLUSION

The study conducted a comprehensive evaluation of the impact of the blending ratio of polyester and cotton fibers on the thermal and moist comfort characteristics of the Interlock knitted fabric structure through a system of four test samples: M1 (100% cotton), M2 (65% PE/35% cotton), M3 (83% PE/17% cotton) and M4 (100% PE). The results of the physical and mechanical analysis showed a strong inverse correlation between the content of synthetic fibers and the ability of the material to manage moisture; specifically, the M1 model with a hydrophilic polarization structure of cellulose achieved a maximum water absorption of 22% and the strongest capillary pressure after 30 minutes, recording a transmission height of 155 mm vertically and 138mm horizontally. In contrast, when the percentage of PE fiber increased, the hydrophobic nature and high crystallization of the polymer severely impaired the hydration capacity, reaching the minimum level at the M4 sample with a hygroscopicity of only 2.58% and the capillary momentum was almost suppressed (15mm longitudinally, 18mm horizontal). However, for the breathable property, the increase in the PE composition establishes a homovariate correlation. While the ruffled characteristic of the cotton fiber in the M1 sample fills the microorgans, increasing the aerodynamic resistance resulting in the lowest air permeability (211L/m^2/s), the smooth surface morphology of the PE fiber helps to expand the empty microorganical space, bringing the M4 sample to its maximum air permeability (1060L/m^2/s).

Overall, the PE/Cotton fiber blend ratio plays a decisive role in the microclimate of Interlock knitting materials; in which, the increase in polyester content is inversely proportional to the absorbent capacity and capillary transmission, but at the same time contributes to a significant improvement in breathability properties. The results of this study also contribute to supplementing the experimental database, serving the design process, improving the quality and improving the customer experience during the use of products from Interlock knitted fabrics. Thereby, it can be an initial suggestion for businesses in choosing the composition of cotton/polyester woven Interlock fabric suitable for the needs of each specific object.

REFERENCES

[1]. Tho Luu Thi, Hai Nguyen Van, Linh Nguyen Trang Hoai, "Effect of weave on some physical and mechanical properties of warp knitted fabrics from PA6/Spandex yarns," in *the 7th HaUI Scientific Conference, Hanoi University of Industry*, 2023

[2]. Tho Luu Thi, Mai Nguyen Thi, "Effect of weave pattern on some physical and mechanical properties of PA/Spandex weft knitted fabrics," in *the 5th HaUI Scientific Conference - Hanoi University of Industry*, 2020

[3]. T Shuganthi, P Senthikumar, "Development of tri-layer knitted fabrics for shuttle badminton players," *Journal of Industrial Textiles,* 48, 4, 738-760, 2018.

[4]. Nilgün Özdil, Gamze Süpüren, Gonca Özçelik, Jitka Průchová, "A study on the moisture transport properties of the cotton knitted fabrics in single jersey structure," *Tekstil ve Konfeksiyon*, 2009.

[5]. Małgorzata Matusiak, Otgonsuren Sükhbat, "Influence of Stretching on Liquid Transport in Knitted Fabrics," *Materials*, 16, 2126, 2023.

[6]. David J Spencer, *Knitting technology*: *A comprehensive handbook and practical guide*. Woodhead Publishing Limited, 2001.

[7]. TCVN 1748:2007 (ISO 139:2005) - *Textiles - Standard atmospheres for conditioning and testing* (In Vietnamese).

[8]. TCVN 5794:1994 - *Knitted fabrics and garments - Method for determination of density* (In Vietnamese).

[9]. TCVN 5799:1994 - Knitted fabrics and garments - Method for determination of yarn length in the loop (In Vietnamese)

[10]. TCVN 5071:2007 (ISO 5084:1996) - *Textile - Determination of thickness of textiles and textile products* (In Vietnamese).

[11]. TCVN 5091:90 - *Fabrics - textiles. Test method for water vapour absorption* (In Vietnamese).

[12]. AATCC TM197 - *Test Method for Vertical Wicking Rate of Textiles to Specified Distances*.

[13]. TCVN 5092:2009 (ASTM D 737:2004) - *Standard test method for air permeability of textile fabrics* (In Vietnamese).