American Journal of Applied Science and Technology

VOLUME Vol.05 Issue 09 2025
PAGE NO. 11-16
DOI 10.37547/ajast/Volume05Issue09-03

Study of the Physical and Mechanical Properties of Mixed Yarn Hosiery Products Based On Closed Knit Fabric

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Received: 19 July 2025; **Accepted:** 18 August 2025; **Published:** 14 September 2025

Abstract: In this article, 4 samples of socks with a closed knit fabric were produced using viscose, bamboo, cotton, polyester and spandex yarns in different proportions. As a result of the analysis of their physical and mechanical properties, recommendations were given to manufacturing enterprises.

Keywords: Viscose yarn, bamboo yarn, coated glad, spandex, KJ606F, water absorption, air permeability.

INTRODUCTION

The hosiery industry is an important branch of the clothing industry, which is produced using knitting technology. Initially, hosiery products were woven from various tree bark and animal skins. During the Industrial Revolution, the invention of new knitting machines had a great impact on the hosiery industry. As a result, the quality of products increased, as well as their prices. Today, the hosiery industry is the fastest growing industry. Enterprises have the opportunity to produce hosiery products that are fashionable and aesthetically pleasing and have improved physical and mechanical properties that meet consumer demand.

Main part

In this study, we effectively utilized the technological features of the single-needle Kejun sock knitting machine to analyze the physical and mechanical properties of 4 different samples obtained from the closed-knit fabric. In modern enterprises, the single-needle sock knitting machine can mainly produce socks with a plain weave. Based on the technological capabilities of the KJ606F sock knitting machine, we were able to obtain a closed-knit fabric by changing the yarn feed angle of the yarn guide.

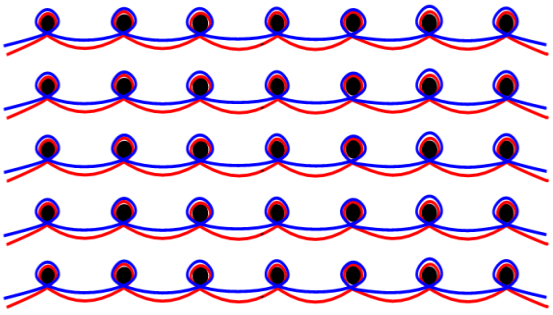

Figure 1. Appearance of a closed knit fabric.

As raw materials, only viscose was used for the inner lining yarn and cotton, bamboo, viscose and polyester yarns were used for the outer part. The samples were produced on a 156-needle KJ606F single-needle sock knitting machine.

Composition of samples based on knitted fabric with a cover

Table 1

№	Raw materials		Linier density, N_e
	Ichki	Tashqi	
1	Viscose	spandex/cotton	30/1
2	Viscose	spandex/bamboo	30/1
3	Viscose	spandex/viscose	30/1
4	Viscose	spandex/polyester	30/1

In the production of samples, 110 D rubber thread was used for the side part of the sock product. In order to standardize the shape retention properties and improve the external design, 3% of 40/75 D spandex thread was used. In this, attention was paid to the naturalness of the cover thread and its high water absorption properties.

Results and Discussions

The physical and mechanical properties of hosiery products were determined and compared to the standard using equipment installed in the textile testing laboratory of Namangan State Technical University.

Physical and mechanical properties of the obtained samples

Table 2

Indicators		Options			
		1	2	3	4
	Inner upper	viscose sp/cot	viscose sp/bam	viscose sp/vis	viscose sp/pol
Yarn type and linear density , T		cotton,bamboo, viscose - 33 T, Spandex - 40/75 d, poliestr - 150 d			
Air permeability V, ($sm^3/sm^2 \cdot sek$)		36,7	35	32,2	32,5
Water absorption , %	Upper	19,9	33,3	46,2	40,3
	inner	3,4	2,9	3,8	2,9
Breaking strength , N	height	254	319	250	246
	width	164	150	176	189
Stretching until breaking, L (%)	height	50,6	69,5	47,8	35,8
	width	76,7	96	91	97
Irreversible deformation , ε (%)	height	20	5	5	7
	width	18	15	10	14
Reversible deformation , ε (%)	height	80	95	95	93
	width	82	85	90	86
Fabric penetration , K (%)	height	2	3	4	2
	width	6	4	5	4

The air permeability of the samples was determined on a YG406 model device based on the GB/5453 (ISO 9237) standard. The samples were tested on a test board with a pressure of 100 Pa using a scale with a diameter of 8 mm. The results showed that option 1, which has a high amount of cotton yarn, has high air permeability, while options 3 and 4, which have an increased amount of polyester yarn, have low air permeability.

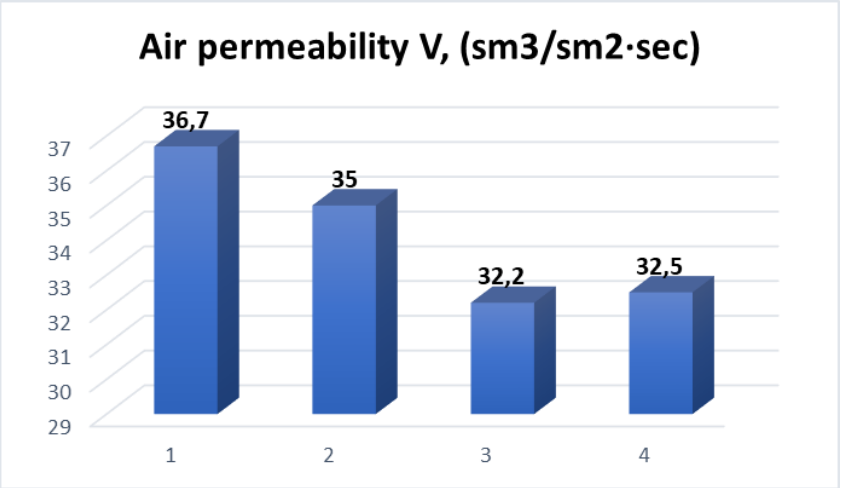

Figure 2. Diagram of air permeability of samples

The water absorption index is an important indicator affecting the hygienic properties of hosiery products. This property was determined using the SDL ATLAS M290 water absorption tester for textile products. The experimental process involves dropping a drop of water on the sample for 2 minutes using a computer, electronically determining the absorbency and providing information in a graphical format. Based on the structure of the fabric, two-way water absorption was studied. In the experiment, the inner layer was made of artificial yarn and was the same, so it achieved a much higher water absorption than the outer layer. The highest water absorption was 46.2%/s and 3.8%/s for the outer and inner layers in option 3. 90% viscose yarn was used in this sample. In samples based on a closed knit fabric, water absorption improves as the proportion of raw materials becomes more uniform. From these results, we can see that the foot absorbs sweat produced by hot weather or excessive physical activity well, and conversely, it slowly transfers moisture from the outside.

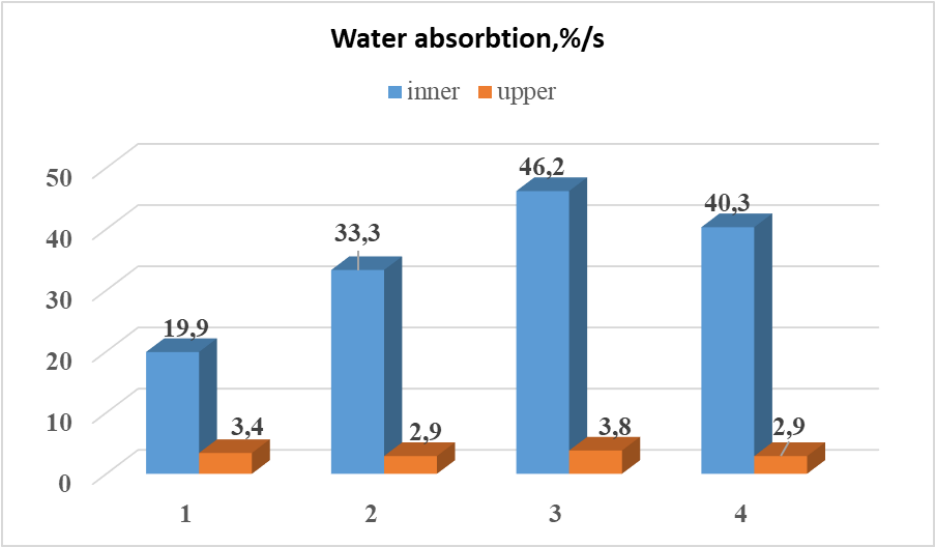

Figure 3. Histogram of water absorption index.

High longitudinal tensile strength of hosiery products increases their resistance to wear stress and reduces the likelihood of tearing. The best performance of these samples was achieved in sample 2 with a force of 319 N along the length, and in sample 4 with a force of 189 N along the width.

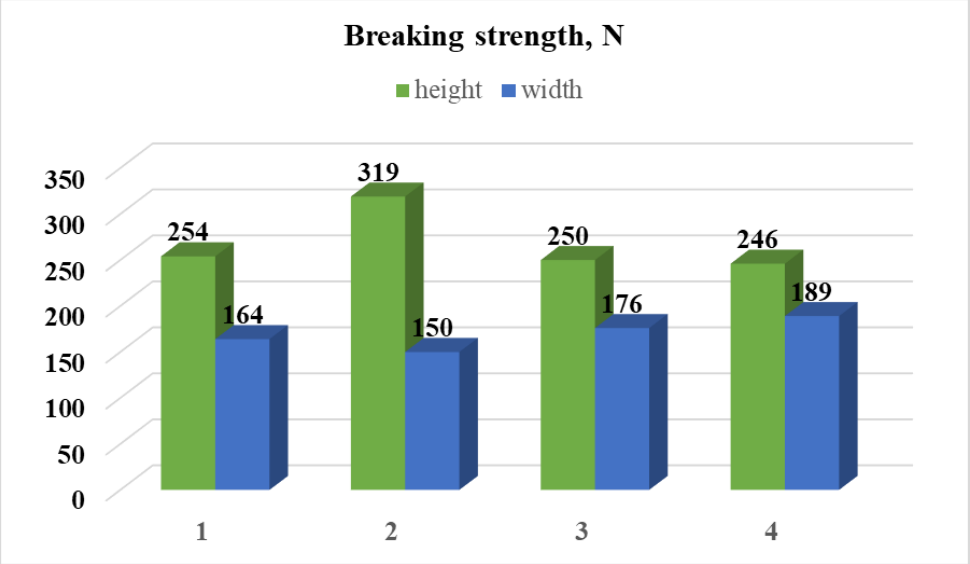

Figure 4. Breaking force histogram.

The deformation index was determined using the YG026A–III equipment. The samples were prepared with a length of 20x5 cm and subjected to a force of 454 g x 3 (13 N) for 30 minutes. According to the standard, the irreversible deformation index should not exceed 20%. All samples met the standard requirements, and variant 3 was recommended as the best sample, due to the closeness of the irreversible deformation in length and width.

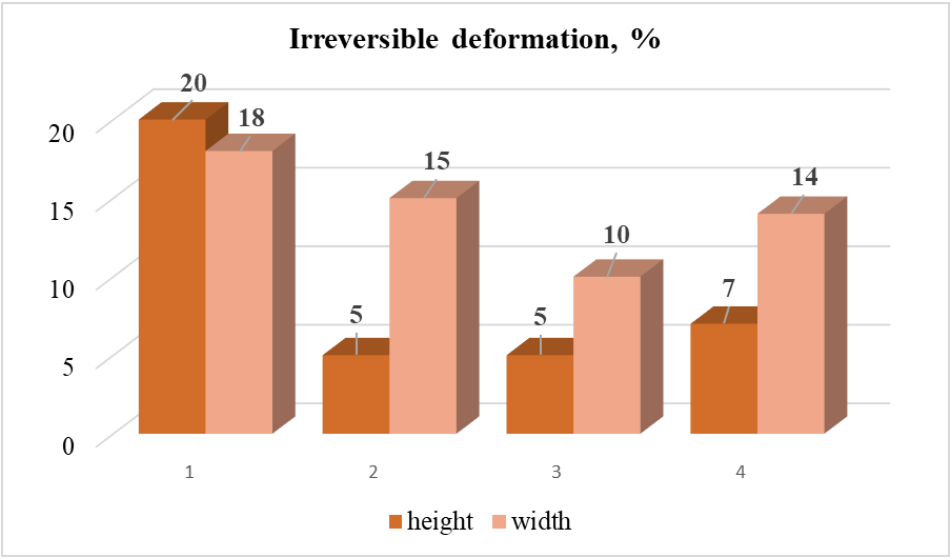

Figure 5. Histogram of the irreversible deformation index.

Shrinkage is one of the important indicators in knitted products. When determining the shrinkage of socks obtained under experimental conditions, the shrinkage index was minimized, despite the presence of spandex yarn in the composition. This is due to the fact that in the production technology of socks, a special shape is given by a hair iron before packaging, as a result of which the shrinkage index is normalized.

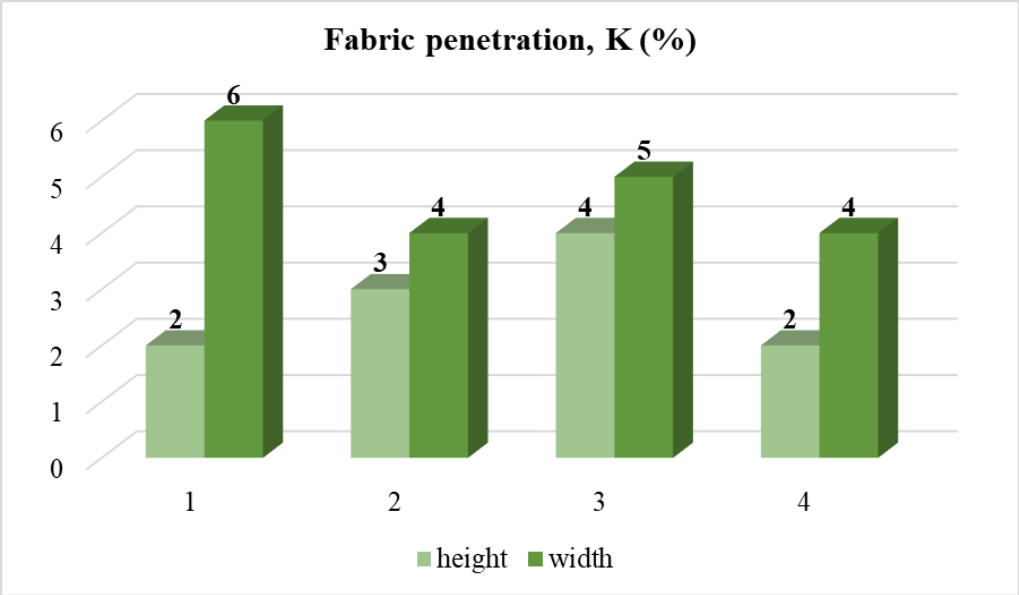

Figure 6. Diagram of the penetration rate of samples

Conclusion

Since the hosiery product simultaneously performs the function of both outerwear and underwear, its physical and mechanical properties require that it meet both criteria. Its properties are evaluated depending on the intended use. This study was conducted mainly on hosiery products produced for the light spring-summer season. As a result, we recommended the production of option 2 and option 3 samples. Because the two main requirements for socks for this season are air permeability and water absorption. The remaining options can be produced as alternatives, since some of the physical properties are higher.

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