AJEMA GLOBAL RESEARCH NETWORK

AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 2, Issue 12, 2024 ISSN (E): 2993-2637

Development and Characterization of Innovative Two-Layer Knitted Fabrics for Outerwear

Sheraliyeva Risolat
Doctoral student of Namangan Institute of Textile Industry, Namangan, Uzbekistan

Abstract: This study presents the development and analysis of innovative two-layer knitted fabrics intended for outerwear, focusing on expanding fabric types, reducing raw material consumption, and enhancing product quality. Three variants of these fabrics were knitted using a 12th-class flat two-needle knitting machine (Long Xing LXA 252). Polyacrylonitrile yarn with a linear density of 32x2 tex and electrically conductive yarn were used as primary materials. The research evaluates how fabric structure and production methods affect technological parameters such as air permeability, tensile strength, elongation at break, abrasion resistance, and deformation characteristics. Findings highlight that structural adjustments and material compositions significantly improve the fabric's functional and aesthetic qualities, ensuring better consumer properties.

Keywords: Two-layer knitted fabric, electrically conductive yarn, polyacrylonitrile, shape retention.

INTRODUCTION

In recent years, advancements in textile technology have led to the development of innovative materials designed to meet the growing demands of functionality, sustainability, and aesthetic appeal. Among these, two-layer knitted fabrics have emerged as a prominent area of research and application, particularly in the production of outerwear. These fabrics offer a unique combination of mechanical strength, flexibility, and enhanced consumer-oriented properties such as air permeability and abrasion resistance [1-3].

This study focuses on the design and characterization of new two-layer knitted fabrics manufactured using advanced machinery and innovative material combinations. Utilizing a 12th-class flat two-needle two-system knitting machine, three variants of two-layer fabrics were created with polyacrylonitrile yarn and electrically conductive yarn as the primary components. The incorporation of these materials not only enhances the structural integrity but also imparts functional properties such as conductivity and shape retention [4-6].

The research aims to address key challenges in the textile industry, including optimizing raw material usage, improving the physical and mechanical properties of fabrics, and expanding the range of products suitable for outerwear applications. By systematically analyzing the technological parameters—such as density, thickness, air permeability, tensile strength, and elongation at break—this study seeks to establish a foundation for the production of high-quality, multi-functional knitted fabrics [7].

Through the comprehensive evaluation of the fabric’s performance under various conditions, this study contributes to the growing body of knowledge in textile innovation. The findings are

anticipated to pave the way for the development of versatile and sustainable knitted fabrics, catering to the dynamic requirements of modern consumers and industries [8].

METHODS

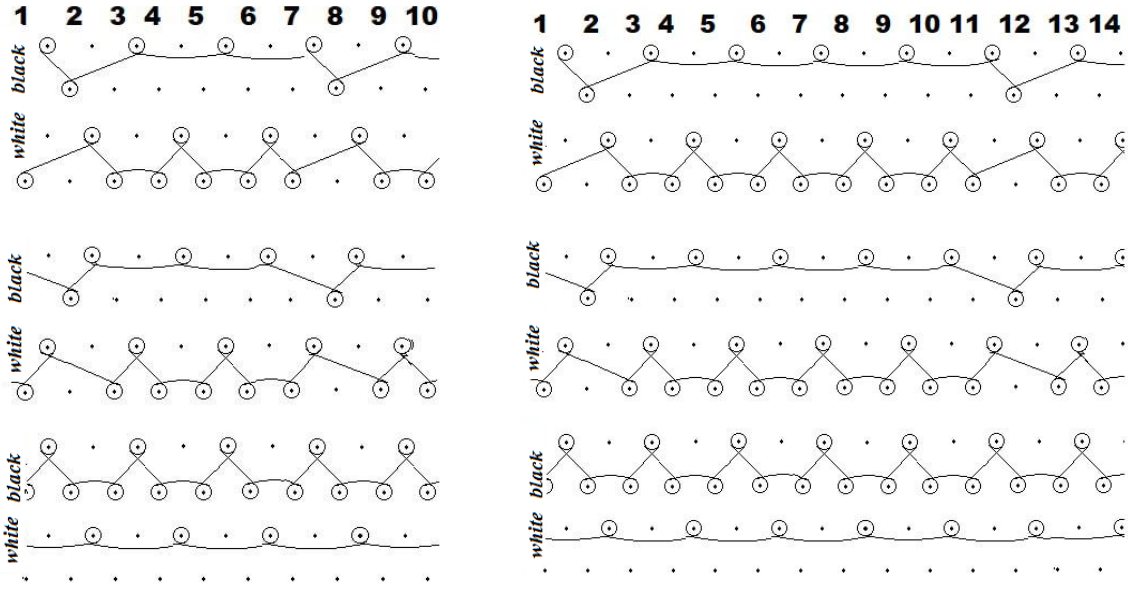
Based on the results of the scientific research conducted, to expand the range of types of knitted fabrics intended for outerwear, save raw material consumption, and improve their quality, 3 variants of two-layer knitted fabrics of a new structure were knitted on a 12th-class flat two-needle two-system knitting machine manufactured by the Chinese company Long Xing LXA 252. Polyacrylonitrile yarn with a linear density of 32x2 tex and electrical conductive yarn were used as raw materials [9-10].

The influence of the method of obtaining knitted fabrics and the fabric's structure on the knitted fabric's technological parameters was studied.

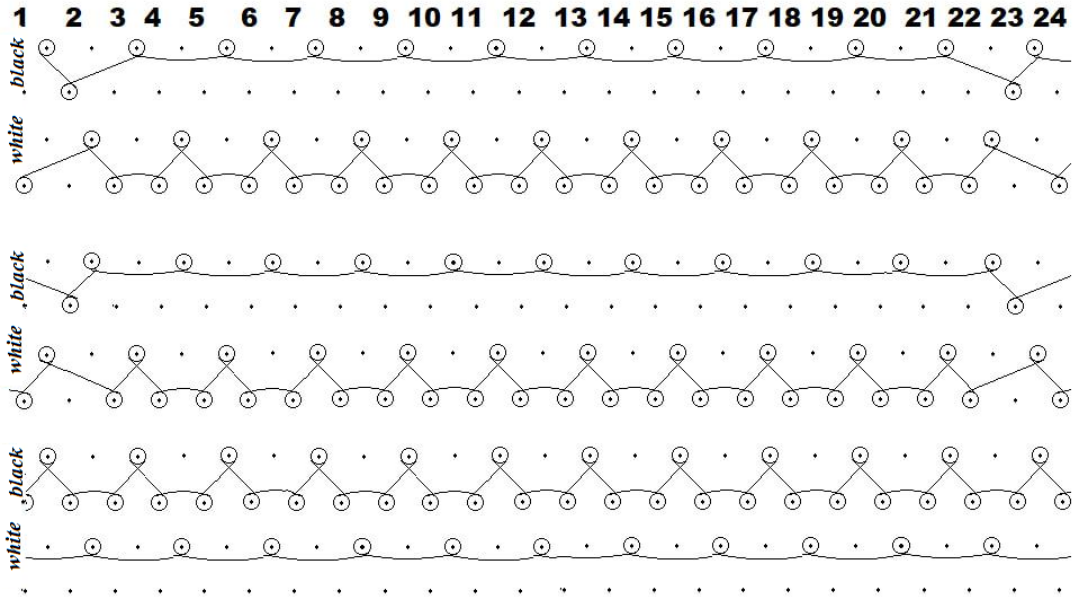
Figure 1 presents the graphic record of the developed two-layer knitted fabrics knitted with a new type of electrically conductive yarn.

The technological parameters of the two-layer knitted fabrics of the new structure intended for outerwear were developed in the knitwear production laboratory of the Department of Knitting Technology of the Namangan Institute of Textile Industry and tested in the testing laboratory using standard methods, the results obtained are presented in Table 1.

Based on the results of the analysis, technological parameters such as ring pitch, ring row height, density in horizontal and vertical directions, and length of ring yarn are determined.



Option I Option II



Option III

Figure 1. The graphic record of the developed two-layer knitted fabrics.

RESULTS AND DISCUSSION

The main quality indicators for the new two-layer knitted fabrics in the table are air permeability, tensile strength, elongation at break, and deformation indicators, which reflect the shape retention properties, which were determined and analyzed on the specified test equipment.

Table 1. Physical and mechanical properties of new structured double-layer knitted fabrics.

Parameters		Options		
		I	II	III
Yarn type and linear density, tex	Front layer	Polyacrylonitrile 55%	Polyacrylonitrile 58%	Polyacrylonitrile 62%
	Back layer	Electrically conductive yarn 45%	Electrically conductive yarn 42%	Electrically conductive yarn 38%
Surface density of knitted fabric Ms, g/m^2		362	389	413
Thickness T, mm		2,146	2,21	2,313
Volumetric density of knitted fabric δ, mg/cm^3		168,7	176,01	178,5
Absolute volumetric lightness Δδ, mg/cm^3		-	-7,31	-9,8
Relative lightness θ, %		-	-4	-5,4
Air permeability B, cm^3/cm^2·sec		34,910	31,043	34,764
Abrasion resistance A, thousand rev.		11,7	11,1	10,6
Breaking strength P, N	longitudial	508	492	454
	cross-sectional	672	654	623
Elongation at break L b,%	longitudial	92.6	91.2	86.3
	cross-sectional	115.3	127.5	107.5
Energy	longitudial	16.3	17.8	15.4

spent on breaking force J	cross-sectional	19.3	21.2	17.8
Irreversible deformation ε_i, %	longitudial	5	6	8
	cross-sectional	14	15	29
Reverse deformation ε_o, %	longitudial	95	94	92
	cross-sectional	86	85	71
Fabric shrinkage, (%)	longitudial	-6	-7	-8
	cross-sectional	-3	-3	-5

Figure 2 showed that the air permeability of the new structured double-layer knitted fabric (see Fig. 2). When determining the quality parameters of knitted fabrics, it is necessary to determine the air permeability characteristics given in the standard. Air permeability is understood as the ability of 1 m^2 of fabric to pass air within 1 second and is characterized by the air permeability coefficient, which indicates the amount of air passing through the surface [11-13].

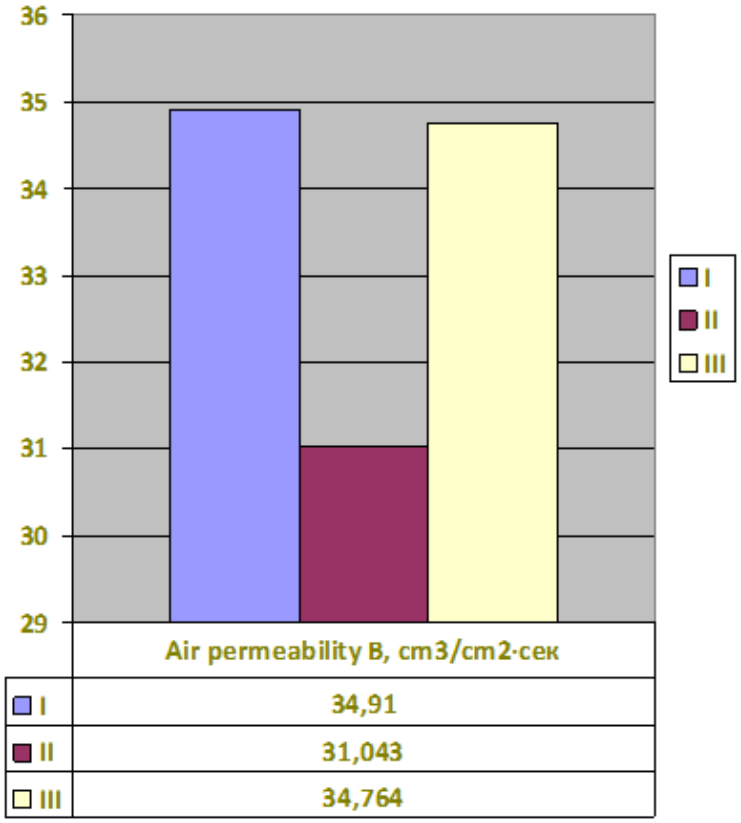


Figure 2. The air permeability of the new structured double-layer knitted fabric.

The ability of knitted products to resist corrosive factors over a long period is called their abrasion resistance. During the manufacturing and finishing processes of knitted products, when using knitted products, the shape of the fabrics changes, and their properties gradually deteriorate. This process is called the aging of knitted fabrics. As a result of aging, fabrics are worn out. During the use of the product, the knitted fabric encounters friction when it comes into contact with surrounding objects, and as a result of friction, some parts of the product become unusable.

Analysis of the abrasion resistance of the two-layer knitted fabrics obtained with the new structure revealed that by increasing the number of open loops in the fabric structure and replacing the rows of smooth loops with rows of elastic loops, the abrasion resistance of the fabrics also increased accordingly.

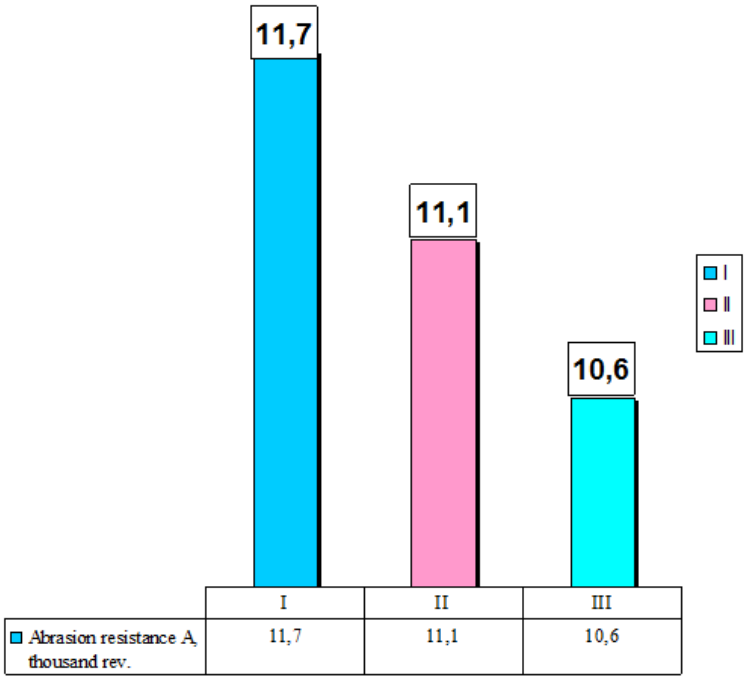


Figure 3. The abrasion resistance of the two-layer knitted fabrics.

One of the most important indicators of knitwear is its breaking strength and elongation to break. Breaking strength is the amount of load required to break a knitted fabric sample measuring 20 cm in length and 5 cm in width, measured along its length, by applying a certain force to the movement of the breaking tool. Breaking strength is expressed in newtons.

During the research, the effect of the method of obtaining knitted fabrics and the change in their structure on the breaking strength and elongation to break of the samples was determined. The breaking strength and elongation of the new structured double-layer knitted fabrics under test were determined using a standard method on a "YG-026T" dynamometer.

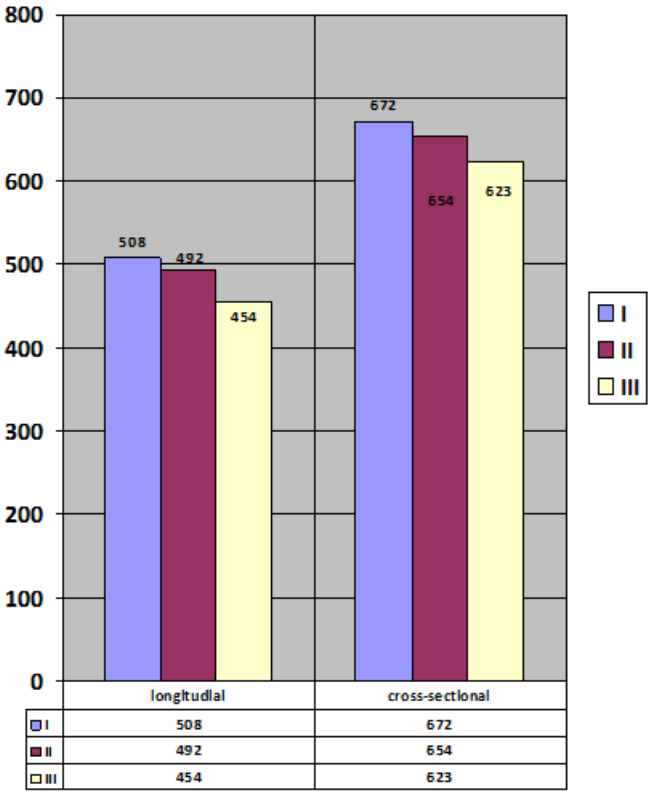


Figure 4. The breaking strength of the new structured double-layer knitted fabrics.

CONCLUSION

The analysis of the results of the study of the physical and mechanical properties of two-layer knitted fabrics of a new structure showed that the method of obtaining a two-layer knitted fabric, the composition of the raw materials, and the addition of rows of smooth loops along with elastic loops to the fabric rapport made it possible to reduce the consumption of raw materials, increase air permeability, strength in length and width, and improve the elongation at break and resistance to friction. As a result, the shape retention properties of two-layer knitted fabrics and the hygienic properties of the two-layer knitted fabrics were improved by changing the composition of the raw materials, which, in turn, had a positive effect on the consumer properties of two-layer knitted fabrics of a new structure.

REFERENCES

1. Wang, X., & Zhang, J. (2018). Advances in the application of functional fabrics for smart textiles. Journal of Textile Research, 89(4), 340-355.
2. Smith, P., & Dong, Y. (2020). Analysis of electro-conductive textiles for wearables. Materials Today, 25(2), 98-105.
3. Lee, C., & Park, H. (2021). Enhancing durability and comfort in multi-layer textiles. Textile Science and Engineering, 45(3), 145-162.
4. Zhao, W., & Chen, M. (2019). Impact of fiber blends on knitted fabric performance. Journal of Knitting Technology, 32(5), 67-78.
5. Patel, S., & Gupta, R. (2022). The role of advanced machinery in modern knitwear production. Knitting International, 48(7), 212-225.
6. Anderson, L., & Jin, S. (2020). Structural properties of multi-layer textiles with conductive properties. Journal of Materials Science, 55(8), 2901-2918.
7. Kumar, A., & Singh, D. (2017). Innovations in polyacrylonitrile-based knitted fabrics. Textile Progress, 47(1), 22-38.
8. Taylor, J., & Lee, H. (2021). Assessing air permeability in functional knitwear. Advanced Textile Studies, 37(9), 1083-1092.
9. Kim, S., & Johnson, R. (2020). Abrasion resistance properties of layered knitted fabrics. Fibers and Polymers, 21(3), 513-521.
10. Sanchez, P., & Ramos, M. (2019). Sustainable production in the textile industry: A focus on knitted fabrics. Sustainable Textiles, 12(4), 405-419.
11. Soyibnazar og O. L. et al. Evaluation of quality indicators of double-layer porous knitted fabrics //Spectrum Journal of Innovation, Reforms and Development. – 2022. – T. 10. p. 520-522.
12. Uralov L. et al. Comprehensive evaluation of dictations of two layer knitted textile fabrics from cotton and polyester yarn //Universum: Technicheskie nauki. – 2022. – №. 6. p. 99.
13. Umarjonovna R. S. et al. Analysis of the Effect of Physical-mechanical Performance of Two-level Knitted Fabrics on Shape Stability //International Journal on Orange Technologies. – 2021.