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RESEARCH ON THE TECHNOLOGICAL PARAMETERS OF NEW-STRUCTURED TWO-LAYER TRICOTAGE TISSUES

Karimova Nilufar
Bukhara State Technical University

G. Sh. Allaniyazov
Berdakh Karakalpak State University

Abstract
This article presents the results of a study on the technological parameters of two-layer top-knitted fabrics with a new structure. In the study, viscose yarn fabrics of various structures were developed on a Long Xing 252 SC 12-class flat-needle knitting machine. The influence of the ring structure of fabrics, weave types, and interlayer connection methods on their physical-mechanical, deformation, and hygienic properties was studied. Based on laboratory tests, density, ring parameters, breaking load, tensile strength, air permeability, and deformation indicators were determined and analyzed. The results showed that by combining weaving elements, it is possible to effectively control the operational properties of the fabrics. The developed double-layer fabrics are characterized by high strength, stable shape retention, and good hygienic properties.

Keywords: Double-layer knitwear, weave types, ring structure, air permeability, technological parameters

Introduction

As an experiment, the developed double-layer top knit fabrics with a new structure were woven on modern technological equipment—a 12-class flat-knitting machine of the Fang type Long Xing 252 SC. This machine possesses high technological precision for forming double-layered knitwear, allowing for stable control of the loop formation process, as well as the use of various interlacing elements in complex combinations.

The structural and technological capabilities of this equipment play an important role in regulating interlayer connections in double-layer fabrics, controlling the geometric parameters of ring elements, and ensuring the stability of the fabric structure. Therefore, the selected machine is appropriate from the perspective of ensuring the reliability and reproducibility of the experimental results. The developed variants of double-layer knitwear differ from each other in their circular

structure, interlacing type, and the spatial arrangement of pattern elements. Specifically, in some variants, derivative interweaving elements were used, while in others, the intensity of interlayer connection was changed using mixed interweaving combinations. This led to the different formation of the structural and operational properties of the fabrics.

The samples of knitted fabric were comprehensively studied under laboratory conditions. The studies were conducted in accordance with current state standards (GOST) and accepted international testing methods for textile materials. During the testing process, specialized certified laboratory equipment and measuring instruments were utilized to ensure the accuracy of measurements and the reliability of results. The technological indicators of fabric samples depending on the machine settings have been comprehensively determined and their relationship has been analyzed. Specifically, the study determined the structural parameters of the fabrics: horizontal and vertical density, surface density, loop pitch, loop row height, and loop yarn length. These indicators characterize the geometric structure of the fabric and have a direct impact on its physical-mechanical and operational properties.

At the same time, the physical and mechanical properties of the fabric samples were measured, including breaking load and tensile strength indicators, and their strength degree was evaluated. To determine the deformation properties, reversible (elastic) and irreversible (plastic) deformations, as well as the degree of shrinkage, were studied. These indicators are of great importance in determining the fabric's ability to maintain its shape during operation.

Additionally, to evaluate hygienic and operational properties, air permeability, abrasion resistance, and bulk density were determined, and their dependence on the fabric structure was analyzed. Based on the results obtained, functional dependencies between machine settings, thread parameters, and fabric structure were determined, which allowed for the determination of optimal technological parameters for new-structure double-layer knitwear.

A comprehensive study of these parameters allowed for the establishment of a relationship between the structural properties of double-layer knitwear and their physical, mechanical, and hygienic indicators. Based on the obtained results, the functional dependencies between the machine settings (thread tension, needle density, weave type) and the fabric structure were analyzed. As a result, it became possible to select optimal technological parameters for new-structure double-layer knitwear.

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Technological parameters of new-structure double-layer knitwear

Indicators	Options				
	I.	II.	III.	IV.	V.
Raw material type and linear density T, tex	Viscose 29.5 tex	Viscose 29.5 tex	Viscose 29.5 tex	Viscose 29.5 tex	Viscose 29.5 tex
Loop pitch A, mm	1.56	2.38	2.00	1.25	1.47
Height of the circular row B, mm	1.28	1.25	1.28	1.14	1.00
Horizontal ring density P_g,	32	21	25	40	34
Vertical density of rings P_v,	39	40	39	44	50
Ring thread length l, mm	6.55	10	6.85	6.59	3.91
Surface density of knitwear M_s, g/m²	720	296	452	612	500
Thickness T, mm	2.31	1.75	2.18	2.67	2.09
Volumetric density δ, mg/cm³	311.69	169.14	207.34	229.21	239.23

The technological parameters of the double-layer knitwear in five different variants developed in the study were compared, and their impact on structural properties was comprehensively evaluated. Since the same raw material—29.5 tex viscose yarn—was used in all variants, the observed differences are explained only by changes in the fabric structure and interlacing elements.

Ring pitch (A) values ranged from 1.25 mm to 2.38 mm, with the highest value observed in variant II and the lowest value in variant IV. It has been established that as the ring pitch increases, the fabric thins, and as it decreases, it becomes dense, and it has been confirmed that this parameter directly affects the overall structural density of the fabric.

The height of the annular row (B) was within the range of 1.00–1.28 mm, with the maximum values recorded in variants I and III, and the minimum values in variant V. A decrease in this parameter leads to fabric compaction in the vertical direction.

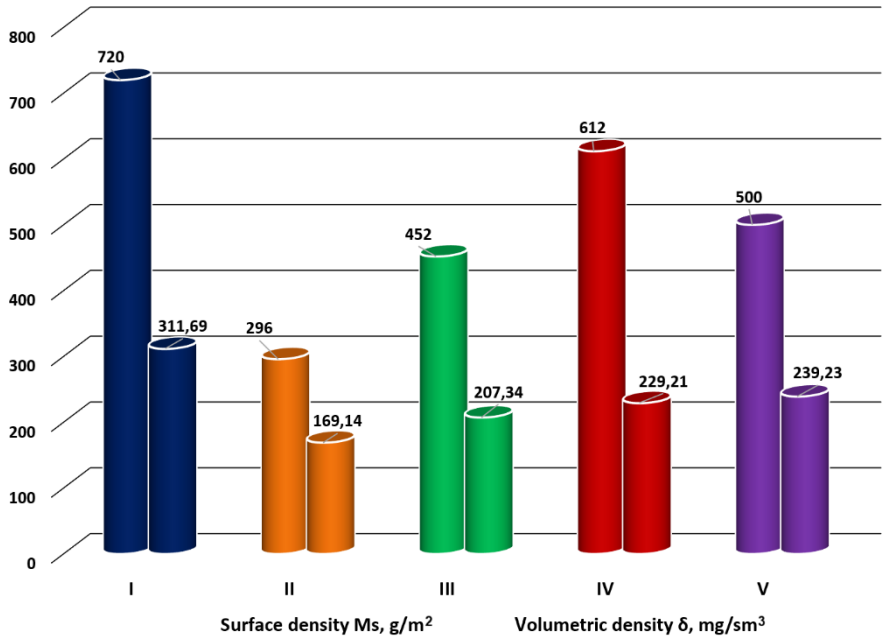
In terms of horizontal density (P_g), variant IV has the highest indicator, while variant II has the lowest, which is explained by the close arrangement of the interlacing elements. The vertical density (P_v) reaches its maximum value in the V variant, indicating that this variant has the most compact structure.

Ring thread length (l) ranged from 3.91 mm to 10 mm, with the maximum value observed in variant II and the minimum in variant V. Increasing the loop length increases the elasticity and softness of the fabric, while reducing it increases its strength and density.

The surface density of the fabric (M_s) ranged from 296 g/m² to 720 g/m², with variant I being the heaviest and variant II being the lightest. The thickness indicator also varied from 1.75 mm to 2.67 mm depending on the structure, with the maximum value observed in variant IV. This indicates high thermal insulation properties.

The bulk density (δ) is in the range of 169.14–311.69 mg/sm³, with variant I being the densest structure and variant II being the lightest. These results clearly demonstrate the relationship between the mass and volume of the tissue structure.

Overall, the results obtained show that by purposefully changing the parameters of the loop and interlacing elements, it is possible to control the technological and operational properties of double-layer knitwear within a wide range. Specifically, variants IV and V possess high density and strength, while variant II is distinguished by its lightness and elasticity. This allows for their selection for various functional purposes.



Histogram of changes in fabric surface area and bulk density

Based on the results of studying the technological parameters presented in the table, the following can be noted: a mutual comparison of the knitwear samples by surface and bulk density showed that variant II of the fabric has the lowest surface and bulk density. At the same time, low density indicators may negatively affect the thermal insulation properties of this variant, but its air permeability and hygienic properties are expected to be high. Therefore, option II is appropriate for upper knitwear products that require lightweight, breathable, and high comfort.

Based on mutual comparison and comprehensive analysis of the obtained experimental results, it can be concluded that among the developed double-layer knitted fabrics, the most effective structural solutions with optimal technological and operational indicators are variants II, III, and IV.

These variants are characterized by relatively low surface and bulk density indicators, which indicates a reduction in their material intensity, i.e., ensures economic efficiency in raw material consumption. At the same time, in these fabrics, as a result of the optimal combination of ring structure and interlacing elements, deformation properties are improved and a high level of shape stability is ensured.

In particular, the optimized degree of interlayer bonding and the balanced selection of loop yarn length led to an optimal combination of elastic and strength properties in these variants. As a result, it was established that these fabrics are relatively resistant to deformation during operation and possess the ability to retain their original geometric shape for a long time.

Thus, based on the conducted research, the most optimal and rational structural solutions for producing high-quality, resource-saving, and functional top-knitted fabrics are the II, III, and IV variants of double-layer knitted structures.

Conclusion

In this article, based on a study of the technological parameters of new-structure double-layer top knitwear, its structural, physical-mechanical, and operational properties were comprehensively studied. During the study, five different variants of viscose yarn-based knitted fabrics were developed, and the influence of their ring structure, weave types, and interlayer connection methods on key quality indicators was determined.

The results obtained showed that the technological parameters of the fabric—the loop pitch, loop thread length, horizontal and vertical density, and the combination of interlacing elements—are the main factors determining its density, strength, deformation properties, and hygienic indicators. The possibility of modifying and optimizing the properties of fabrics within a wide range through purposeful control of structural parameters has been scientifically substantiated.

According to the results of the experiments, it was established that double-layer knitted fabrics of variants II, III, and IV have the most optimal indicators, and it was proven that they are characterized by reduced material intensity, high shape stability, and good operational performance.

As a result, the developed new structural solutions have been recommended for use in the production of top-knitted products, and it has been substantiated that they are of important scientific and practical importance in creating resource-saving, high-quality, and competitive products.

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