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Analysis of the effect of physical-mechanical performance of two-level knitted fabrics on shape stability

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Abstract: *The article presents the results of the analysis of physical and mechanical properties of 4 variants of knitted fabric.*

Key words: *knitting, knitwear, woven structure, spun puzzle, pan, polyester, air permeability, deformation, tensile strength, glad, press*

INTRODUCTION

Physical and mechanical properties of knitted fabrics were tested in the laboratory of the Namangan Institute of Engineering and Technology by standard methods, the results of which are given in the table many properties of knitted fabric are directly related to its thickness index. These include air permeability, heat retention, abrasion resistance. The air permeability property of textile materials is extremely important in evaluating clothing from a hygienic point of view, as it is related to the ventilation of the air under the garment and significantly determines the heat retention property of the material.

The air permeability index of textile materials often depends on the porosity and the size of the open holes, as well as the thickness of the knit (87; 213-222 sh.)

6 samples of patterned knitted fabric structures were produced on the 12-class LONG-XING SM 252 knitting machine with flat needle.

The report of knitted fabric consists of rows of glad and press. Knitted fabrics differ from each other by changing the type of raw material and the sequence of fabric reports.

Patterns of knitted fabrics were developed using linear density 16 tex polyester yarn, linear density 35x2 tex spun polyacrylonitrile and linear density 50 tex spun cotton yarn.

Among the indicators characterizing the physical-mechanical properties of knitted fabrics are the following: strength and elongation at break, elongation under stress less than tensile strength, resistance to single and repeated elongation, resistance to shrinkage and abrasion, resistance to heat and wet processing [1] .

In order to study the effect of polyacrylonitrile and polyester and spun cotton yarns on the physical and mechanical properties of the fabric, the physical and mechanical properties of 6 variants of samples of knitted and woven fabrics based on single and double layers and their derivatives were tested experimentally

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on modern equipment installed in NamETI identified and the results obtained are presented in Table 1 [2].

Air permeability is the permeability of the materials themselves. The higher the porosity of the material, the smaller the weight filling and the higher the air permeability.

Air permeability is characterized by a coefficient indicating the amount of air passing through 1 cm2 of fabric in 1 second at a given pressure difference on both sides of the material.

The air permeability property of woven knitted fabrics was tested on equipment YG461E based on GB / 5453 (ISO 9237) standard. GB / 5453 (ISO 9237) was tested under normal conditions for a pressure of 100 Pa and a range of Ø 8.0 mm for ready-to-wear fabrics.

The air permeability coefficient V (cm^3 / cm^2 sec) is determined by the following formula.

$$B = \frac{V}{S \cdot T}\ sm^3 / sm^2 \cdot \sec \quad (1)$$

In here: B - the amount of air passing through the fabric at a given pressure difference ΔP,sm^3;

S - fabric area, sm^2;

T - the time of passage of air through the fabric, sec.

The air permeability properties of woven knitted fabrics vary from 290.2 sm^3/sm^2*sec to 680.27 sm^3 / sm^2sec.

The lowest air permeability was observed in variant IV of knitted fabric, and its volume was 29.02 sm^3 / sm^2*sec. This figure is 9.48 sm^3 / sm^2 sec more than variant I tissue. The highest air permeability was observed in variant V of the knitted fabric samples and its volume was 68.03 sm^3 / sm^2*sec. (Table 1, Figure 1).

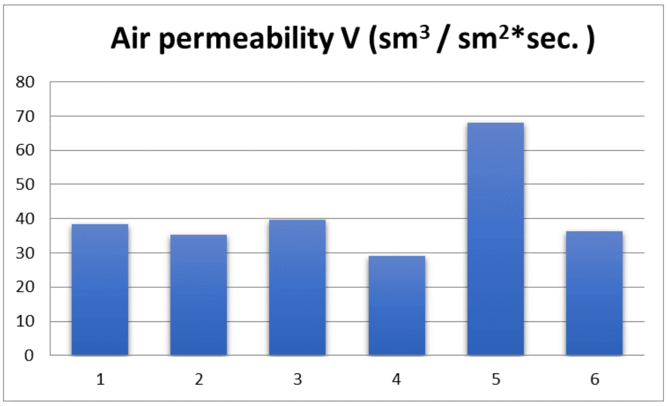
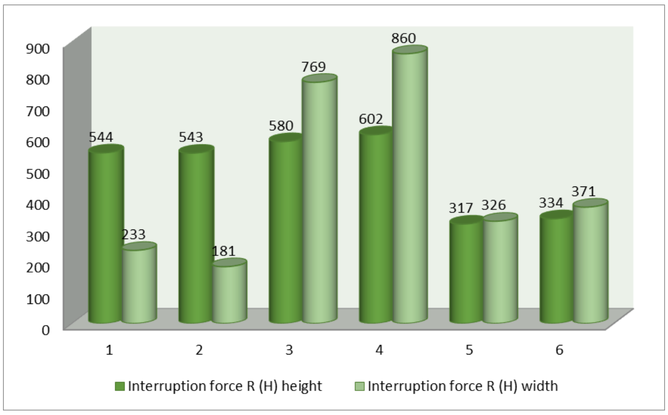


Figure 1. Air permeability histogram of knitted fabric

The tensile strength characteristic is an acceptable key indicator for assessing the quality of knitted fabrics. All GOST and TSH applicable to knitted fabrics include normative indicators on elongation and tensile strength. Tensile strength is the force required to break a specimen at a given size and speed. The breaking force is expressed in Newtonian units. The tensile strength of the submitted samples was determined using the standard method YG-026T dynamometer. Tissue toughness, i.e., tensile strength analysis, showed that the most mature tissue in height, variant IV, had an index of 602N, which was 47.4% higher than variant B (Table 1, Fig. 2). This is due to the presence in the fabric structure of woven ring pillars based on a press tissue structure made of high-volume spun polyacrylonitrile yarn. The strength of the tissue width was also observed in variant IV, which had a tensile strength of 860 N across the width of the tissue, an increase of 11% compared to variant III. Because the fabric consists of PAN 35tex2, p / e 16 tex3, spun cotton 50 tex 3 yarns and the fabric structure consists of press fabric rings.



cotton 50 tex4 yarns. The elongation of the II-variant of knitted fabric along the neck was the lowest, it was 29.15%.

Figure 2. Histogram of change in tensile strength of knitted fabrics

The elongation of a knitted fabric is understood as its elongation under the influence of the force expended. Elongation is characterized by the elongation of the sample being tested. Elongation is expressed in absolute or relative units. When knitted fabrics with a length of 100 mm clamped to the tool are tested, their absolute and relative sizes are the same.

Table 1

Physical and mechanical properties of knitted fabrics

INDICATORS		OPTIONS					
		1-sample	2-sample	3-sample	4-sample	5-sample	6-sample
Type of yarn, linear densities and percentage % of fabric		PAN35x2 PAN 35x2	PAN 35x2 х/б 50x4	PAN 35x2 х/б 50x4 п/э16 tex2	PAN 35x2 х/б 50x3 п/э 16 tex3	PAN 35x2 п/э 16 tex4	PAN 35x2 х/б 50x4 п/э 16 tex2
Surface density Ms (gr / m2)		380	430	376	433	180	505
Fabric thickness T (mm)		2.7	2.8	2.52	2.62	1.5	2.9
Volume density δ (mg / cm3)		140	150	149	165	120	153.2
Air permeability V (cm3 / cm2 · sec)		38,5	35,4	39,8	29,02	68,03	36,24
Interruption force R (H)	height	544	543	580	602	317	334
	width	233	181	769	860	326	371
Stretching to break L (%)	height	56.8	29.15	39.8	51.6	39.3	55
	width	63.7	49.4	27.6	78.55	49.55	74.05
Irreversible deformation $\varepsilon_{н}$ (%)	height	64	85	57.7	53.8	45.7	41.7
	width	52.2	67	56.5	78.4	13	50
Back deformation ε_{o}(%)	height	36	15	42.3	46.2	54.3	58.3
	width	47.8	33	43.5	21.6	87	50
Fabric initiative K(%)	height	1.3	1	1	1	1	2
	width	3	2	1	1	3	3
Friction resistance I (thounsand. circle)		48.4	51.1	49	52.3	53	54.3

The length elongation of knitted fabrics ranges from 29.15% to 56.8%. The highest elongation was observed in variant I of the knitted fabric and it was 56.8% (Table 1). It was found that the elongation of the knitted fabric in variant I was 3.2% higher than in variant VI. Because the fabric consists of PAN 35tex2, p / e 16 tex2, spun

The elongation across the width of the knitted fabric ranged from 27.6% to 78.55%. The maximum width elongation was observed in option IV of the knitwear and it was 78.55%. The minimum width elongation was observed in variant III of the knitted fabric, which was 27.6%. The width of the knitted fabric variant VI is 11%

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more than the width of the variant I, the length of the knitted fabric

The elongation of variant II is close to the elongation of variant B tissue.

In summary, the amount of elongation along the length and width of a knit will depend on the structure of the knitted fabric and the type of yarn it contains.

When designing products, it is important to know what elastic properties knitted fabrics have [3].

The total deformation ε consists of the following parts: the flexible part ε_q rotates at high speed after the loads are removed from the samples being tested; elastic deformation ε_e develops at a small rate, associated with the passage of the relaxation process; plastic deformation ε_p, does not return after removal of loads from samples.

$$\varepsilon = \varepsilon_K + \varepsilon_Э + \varepsilon_n, \% \quad (2)$$

The deformation of the knit varies with the elasticity, stiffness, and number of loops of the yarn. Not only the description of the deformation, but also the state of the knitting is determined by the internal, two main forces: the elastic force of the yarn bending to the ring tends to straighten the yarn and change its shape. The result is a frictional force between the yarns, which prevents the placement of the yarns in the loop and interferes with the structure of the knitted fabric [4,5].

Deformation properties were determined on the model YG026A - III. Samples were prepared 30x5 cm long and subjected to a force of 454 g x 3 (13 N) for 30 min.

According to the results obtained, the proportion of longitudinal deformation in knitted knitted fabric samples varies from 86.3% to 93.5%, and the proportion of reverse deformation in width varies from 84% to 91% (Table 1, Fig. 3). Such indicators of the proportion of back deformation indicate that the knitted fabric quickly returns to its original position after stretching.

In the process of wet processing of knitted fabrics (washing, drying) the decrease in size is called penetration, and the increase is called tensile.

Knitted fabrics have a significantly higher elongation than woven fabrics and have a highly elastic structure, even under the influence of small stresses. The principle of operation of machines for the finishing of knitted fabrics is almost no different from the machines for the finishing of woven fabrics. It has been noted that one of the main reasons for the high level of penetration is the excessive deformation of knitted fabrics in finishing operations.

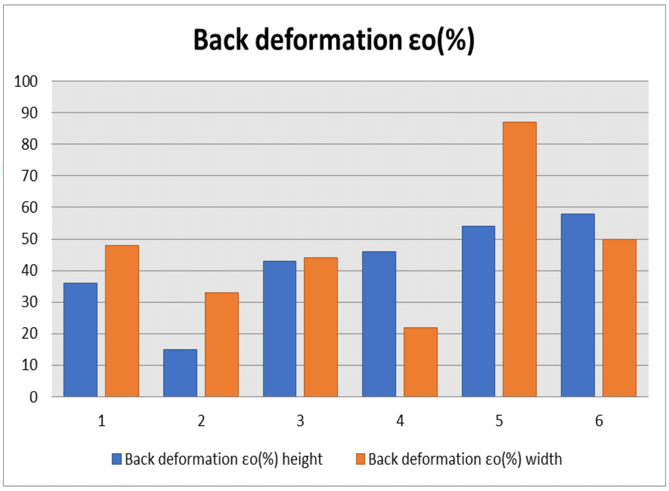

Figure 3. Histogram of re-deformation of knitted fabrics

When knitted fabrics are processed, the less the knit enters, the higher its shape-retaining properties. Studies have been conducted to study the effect of the amount of polyacrylonitrile and polyester yarns in the composition of knitted fabrics on the elasticity. The results of the study of the penetration process of patterned knitted fabric samples showed that the penetration varied from 1% to 3% in height and from 1% to 2% in width (Table 1, Fig. 4).

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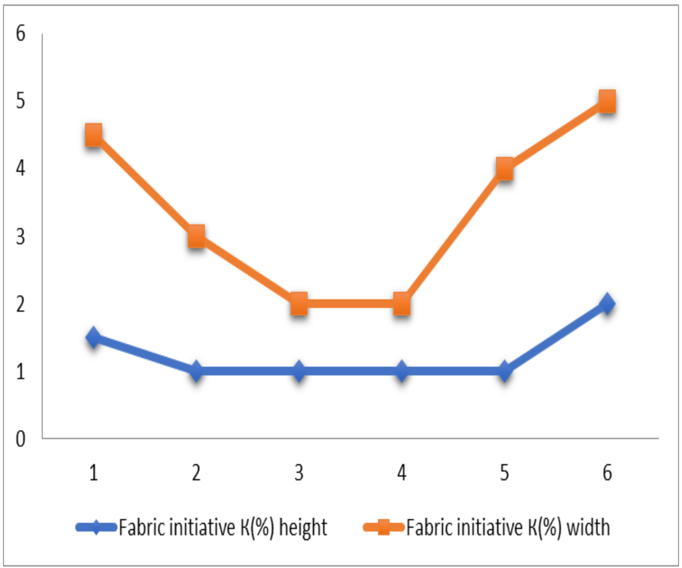

Figure 4. Introduction to Knitted Knitting histogram

During the use of knitted products, the fabric is subject to abrasion when in contact with surrounding objects, and some parts of the product change shape, resulting in wear and tear.

The variants with the highest abrasion resistance of the resulting knitted fabric are the VI and V variants. Option VI abrasion resistance 54.3 thousand months. Option V has a friction resistance of 53,000. It was found that the friction resistance of option VI was 112.1% higher than the friction resistance of option I (Table 1).

The analysis of the above-mentioned physical and mechanical properties of knitted fabrics shows that the increase in the amount of high-volume spun polyacrylonitrile, spun cotton, and polyester yarns has a positive effect on the air permeability, toughness, elongation and abrasion resistance of knitted fabrics.

Knitted fabrics contain high-volume spun polyacrylonitrile, spun cotton, mixed with knitting, which allows to obtain knitted products with high hygienic and shape-retaining properties, toughness and beautiful appearance.

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