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Analysis of Qualitative Indicators of Knitwear with Different Yarn Linear Density

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Abstract:

The article is devoted to the study of the effect of changing the linear density of the yarn of the back layer of two-layer knitwear. Investigated five variants of two-layer knitwear, in the production of which linear cotton yarn was used. In this case, the linear density of the yarn of the front layer remained unchanged, and the linear density of the yarn of the back layer changed. The physical and mechanical properties of the obtained samples of two-layer knitwear are analyzed.

Keywords: double-layer knitwear, yarn liner density, properties, analysis.

Introduction. Product quality is a combination of product properties that determine its suitability to meet certain needs in accordance with its purpose.

For a complete assessment of the quality of textile materials, it is important to reasonably choose a set of quality indicators. A product quality indicator is a quantitative characteristic of one or several properties of a product, considered in relation to certain conditions of its operation or consumption [1].

When assessing the quality of knitted fabrics, compliance with the norms of indicators of physical and mechanical properties is taken into account; the presence of external defects that reduce their artistic and aesthetic assessment; color fastness.

Standardized indicators of physical and mechanical properties of knitted fabrics are divided into general, mandatory for all types of fabrics and additional, depending on the purpose and fibrous composition of the fabric. The general physical and mechanical characteristics of knitted fabrics include: the composition of raw materials, the percentage of various fibers, the linear density of the threads, the density of the knitting of the fabric horizontally and vertically, the breaking load. Additional indicators for outerwear and underwear knitted fabrics are extensibility and abrasion resistance.

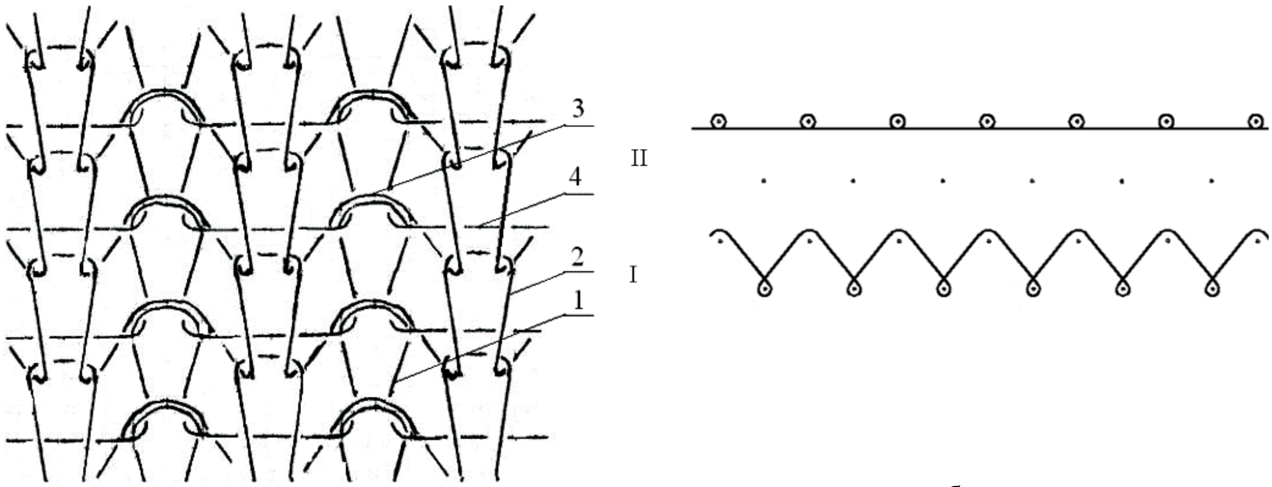
If at least one indicator of the canvas does not meet the standards, it is rejected.

Experiments and research. In order to study the influence of the linear density of the thread of the outer layer of a two-layer knitted fabric on its physical and mechanical properties, five variants of two-layer knitted fabric were developed on a Long Xing 252 SC flat-fanged machine. The variants of the two-layer knitwear differed from each other in the linear density of the thread of the outer layer of the knitted fabric. Two-layer knitwear was developed on the basis of semi-fan weaving, where the press method of joining with warp threads is used to join the layers of knitted fabric.

In fig. 1 shows the structure and graphic record of a two-layer knitwear.

The structure of a two-layer knit is illustrated in Fig. 1, a. The jersey consists of elongated purl loops 1, knit loops 2, outline 3 and broaches 4.

In the formation of one rapport of the proposed two-layer knitwear on a flat-fanged machine, two loop-forming systems are involved.



а

б

Fig. 1. Structure (a) and graphic record (b) of the production of two-layer knitwear

The first system forms a press row, and the second system, on the needles of the rear bed, forms the stitch rows of the smooth surface (Fig. 1, b).

Cotton yarn with a linear density of 20 tex was used as a raw material for the front and back sides of two-layer knitwear.

The developed weave samples were tested for physical and mechanical properties according to the standard method (GOST 884-87) in the laboratory conditions of TITLI and in the certification center “CentexUz” [2,3]. Physical and mechanical properties of samples of knitted fabrics are shown in table 1.

Table 1: Technological parameters and physical and mechanical properties of two-layer knitwear

Indicators		Variants				
		I	II	III	IV	V
Type and liner density of yarn	Face layer cotton yarn	20 tex x 1	20 tex x 2	20 tex x 3	20 tex x 4	20 tex x 5
	Back layer cotton yarn	20 tex x 3				
Content of yarn in fabric, %	Face layer	34	55	63	67	71
	Back layer	66	45	37	33	29
Surface density M_S , g/m^2		398,4	455,0	511,4	578,2	597,5
Thickness T, mm		0,9	1,3	1,3	1,4	1,6
Volume densiry δ, mg/sm^3		442,6	350	393,4	413	373,4
Air permeability B, sm^3/sm^2·sek		171,1	158,7	112,7	104,7	116,2
Abrasion resistance И, thousand turns		23,8	24,6	Over 30	Over 30	Over 30
Break load P, H	by length	305	230	309	333	322
	by width	310	309	320	330	300
Break elongation L, %	by length	120	85	97	103	89
	by width	91	90	114	110	114
Elongation at 6N, %	by width	19	17	18	19	19
Irreversible deformation ε_H, %	by length	28	27	20	20	13
	by width	33	29	24	22	15
Reversible deformation ε_O, %	by length	72	73	80	81	87

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	by width	67	71	76	78	85
Shrinkage У, %	by length	11	10	10	11	12
	by width	-7,8	-6	-5,6	-7,3	-7

As mentioned above, in the future, we will consider the test results with samples of weave variants based on two-layer knitwear.

Investigating the physical and mechanical properties of two-layer knitwear (Table 1), it was determined that the highest air permeability index has the I variant - 171.1 cm^3 / cm^2 • s, after it the II variant - 158.7 cm^3 / cm^2 • s, V variant-116.2 cm^3 / cm^2 • s, variant III-112.7 cm^3 / cm^2 • s and IV variant - 104.7 cm^3 / cm^2 • s. If we compare in percentage terms, the difference in the values of air permeability between the variants is as follows: the fourth and first-39%, the third and first-34%, the fifth and first-32%, the second and first-15%. In general, the air permeability of the developed variants varies within 39%; they can be recommended for production depending on the properties and based on the functions and purpose of the product (Table 1, Fig. 2).

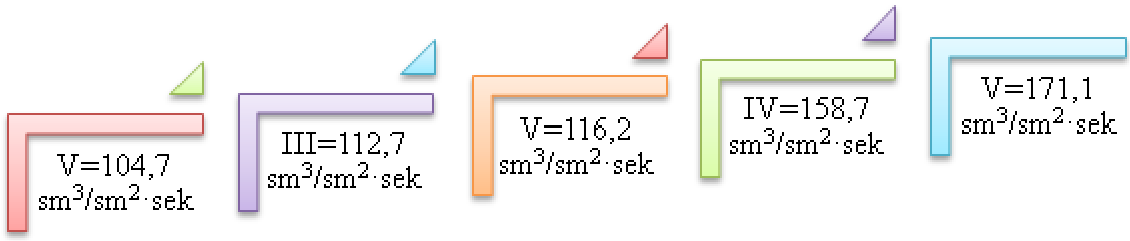

Fig. 2. Air permeability of two-layer knitwear

The abrasion resistance of the tested samples corresponds to the standards of abrasion resistance of knitted fabrics for outerwear [4]. The most resistant to abrasion were knitted fabric samples, made from cotton yarn with an increased linear density of the outer layer of a two-layer knitted fabric (Fig. 3).

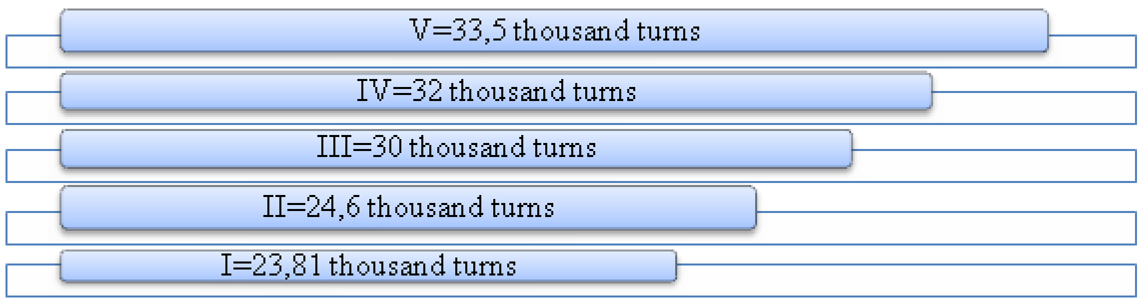

Fig. 3. Histogram of changes in abrasion resistance of two-layer knitwear

If we judge the effect of a decrease in the bulk density of knitted fabric on its strength characteristics (Figs. 4 and 5.), then the obtained histogram shows that the breaking load along the length in the IV variant is greater than in the other variants. Variant IV has the highest breaking load in the length - 333 N, in the width - 330 N.

The breaking load of the first version is 305 N in length, 310 N in width, the breaking load of the second version is

in length - 230 N, in width - 309 N, the breaking load of the third version is 309 N in length, 320 N in width, the breaking load of the fourth version is 333 N in length, 330 N in width, the breaking load of the fifth version is in length - 322 N,

in width - 300 N.

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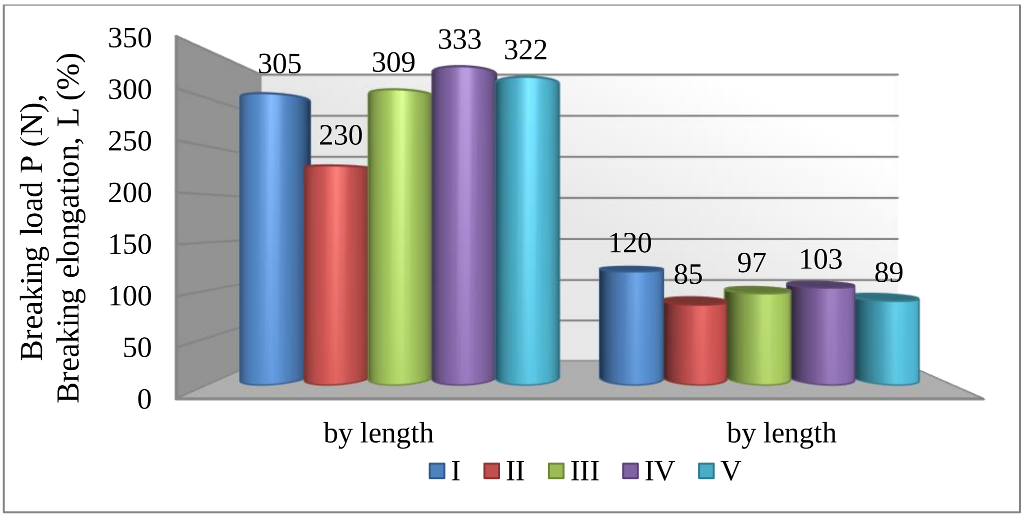

Fig. 4. Histogram of changes in breaking load and breaking elongation along the length of two-layer knitwear

The fourth variant has the highest breaking load in length. The difference between breaking loads in comparison with the fourth variant for the second variant in length decreases by 31%, for the first variant it decreases by 8%, for the third variant it decreases by 7%, for the fifth variant it decreases by 3%. In general, the breaking load along the length of the developed variants varies within 31%, they can be recommended for development as variants with increased strength along the length, depending on the properties and based on the function and purpose of the product.

The fourth variant has the highest breaking load in width. The difference between breaking loads in comparison with the fourth variant for the fifth variant in width decreases by 9%, for the second variant it decreases by 6%, for the first variant it decreases by 6%, for the third variant it decreases by 3%. In general, the breaking load along the width of the developed variants varies within 9%, they can be recommended for development as variants with increased strength in width, depending on the properties and based on the function and purpose of the product.

Elongation at break is the deformation that occurs under the action of a tensile load at the time of rupture of the knitted fabric.

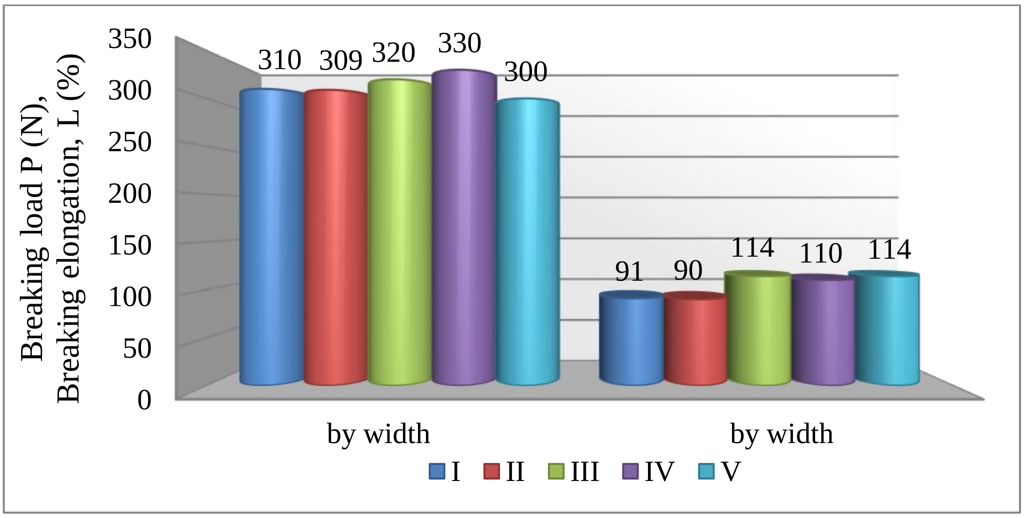

Fig. 5. Histogram of changes in breaking load and breaking elongation across the width of two-layer knitwear

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According to the test results given in Table 1, it can be seen that the second variant has the lowest breaking elongation in length - 85% and in width - 90%. The breaking elongation of the first variant is

in length - 120%, in width - 91%, breaking elongation of the second variant is 85% in length, in width - 90%, breaking elongation of the third variant is 97% in length, 114% in width, breaking elongation of the fourth variant is 103% in length, in

width - 110%, breaking elongation of the fifth variant is 89% in length, 114% in width. The difference between breaking elongations in comparison with the second variant for the fifth variant in length increases by 4.5%, for the third variant it increases by 12.4%, for the fourth variant it increases by 17%, for the first variant it increases by 29.2%.

In general, the elongation at break along the length of the developed variants varies within 29.2%, they can be recommended for development as variants with increased dimensional stability along the length, depending on the properties and based on the function and purpose of the product.

The difference between breaking elongations in comparison with the second variant for the first variant in width increases by 1%, for the third variant it increases by 21%, for the fourth variant it increases by 18%, for the fifth variant it increases by 21%. In general, the breaking load along the length of the developed variants varies within 21%, they can be recommended for development as variants with increased dimensional stability in width, depending on the properties and based on the functions and purpose of the product.

According to the test results given in Table 1, it can be seen that the first variant has the highest rate of irreversible deformation along the length and width - 28% and 33% (Fig. 6 and 7). Here, the features of the newly developed variants are that the dynamics of change at breaking elongation has closer values in length and width. The hinge structure of the developed new variants is more stable and balanced. Irreversible deformation along the length of the first variant is 28%, the second variant is 27%, the third and fourth

variant - 20%, fifth variant - 13%, irreversible deformation in the width of the first variant - 33%, second variant - 29%, third variant - 24%, fourth variant - 22%, fifth variant - 15% [5,6].

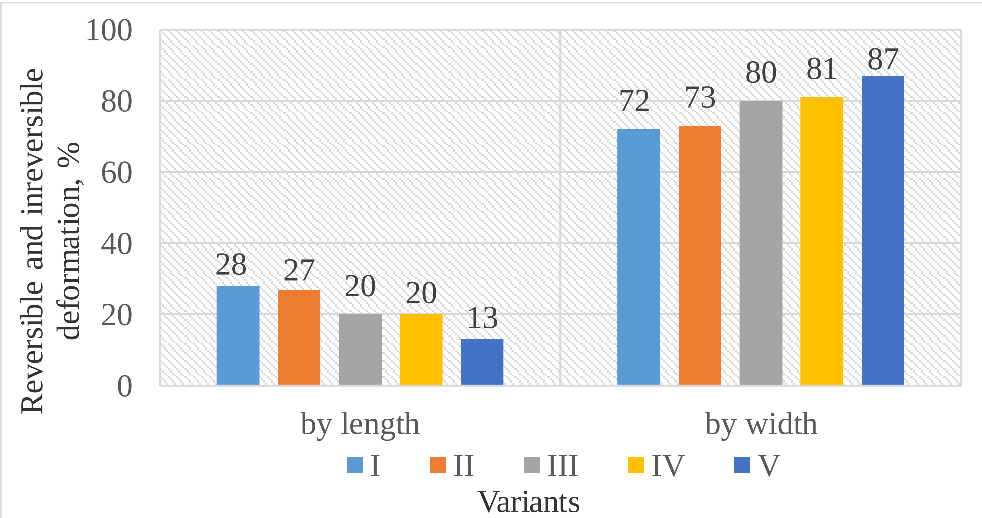

Fig. 6. Histogram of changes in irreversible and reversible deformation along the length of a two-layer jersey

The difference between irreversible deformation in length compared with the first variant for the second variant decreases by 4%, for the third and fourth variants it decreases by 29%, for the fifth variant it decreases by 54%. The irreversible deformation in width in comparison with the first variant for the second variant is reduced by 12%, for the third variant it is reduced by 27%, for the fourth variant it is reduced by 33%, for the fifth variant it is reduced by 55%.

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According to the test results shown in Table 1, it can be seen that the fifth and fourth variants have the highest reversible deformation rate in length - 87 and 81%, and in width the fifth variant has the highest reversible deformation rate - 85%. It should also be noted here that the peculiarities of the newly developed variants are that the dynamics of change at breaking elongation has closer values in length and width. The hinge structure of the developed new variants is more stable and balanced. The reversible deformation along the length of the first variant is 72%, the second variant is 73%, the third variant is 80%, the fourth variant is 81%, the fifth variant is 87%, the reversible deformation is 67% in the width of the first variant, 71 %, third variant - 76%, fourth variant - 78%, fifth variant - 85%.

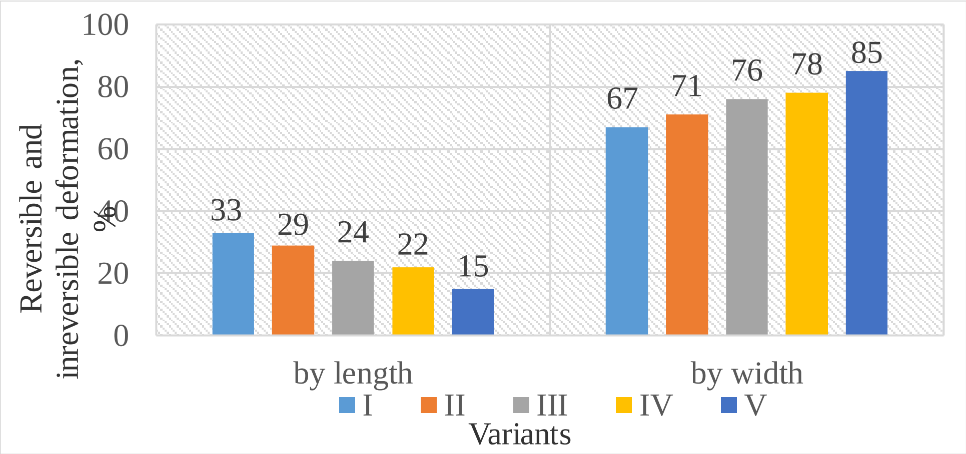

Fig. 7. Histogram of changes in irreversible and reversible deformation across the width of a two-layer jersey

The difference between the reversible deformation in length compared to the fifth variant decreases by 20.8% for the first variant, for the second variant it decreases by 21.9%, for the third variant it decreases by 8.7%, for the fourth variant it decreases by 8.1% ... The reversible deformation in width compared with the fifth variant for the first variant decreases by 26.8%, for the second variant it decreases by 19.7%, for the third variant it decreases by 11.8%, for the fourth variant it decreases by 9% (Fig. 6 and 7).

Conclusion. Analyzing the generalized reversible deformation, we can recommend the fifth variant as having the highest value of elasticity in length and acceptable in width compared to other variants.

The results of the complex diagram and the histogram of the quality indicators of two-layer knitwear showed that the best variants for two-layer knitwear obtained from cotton yarn are variants IV, V and III. These variants have high dimensional stability, appropriate hygienic properties and reduced material consumption.

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