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Investigation of Technological Parameters and Physic-Mechanical Properties of an Inlay Knitted Fabric on the Base of Double-Layer Stitch

Allamuratova T. K., Mukimov M. M.

Doctoral student of Tashkent Institute of Textile and Light Industry, Uzbekistan.
D.Sc., prof. Tashkent Institute of Textile and Light Industry, Uzbekistan.

ABSTRACT: In order to reduce the consumption of raw materials, improve the shape-stability of knitwear and improve the quality of knitwear due to the strong fixing of the inlay yarn in the ground stitch, structures and knitting way of inlay two-layer knitted fabric have been developed. The presence of a inlay yarn in the structure of a two-layer knitted fabric increases its thickness and reduces the volume density by 8-12%. The article presents the results of an investigation of the effect of fastening of an inlay knittted fabric in the ground of double-layer stitch on its technological parameters and properties.

KEYWORDS: Knitwear Strength, Tensile strength at less tensile loads, Abrasion resistance, Shrinkage at wet-heat treatment, Material consumption, Double-layer knitted stitch, Inlay knittted fabric, Structure of stitch, Consumption of raw materials, Volume density, Form-stability.

I. INTRODUCTION

Recently, the range of knitted goods have expanded significantly. It was enriched with new types of knitted fabrics, in particular, fabrics of lightweight structures, such as plush, combined and double-layer, produced, mainly, on double needle bar machines. To develop new structures based on the above-mentioned stitches for creating lightweight fabrics, we analyzed the existing structures and methods of their production on different types of knitting machines.

The economical use of raw materials creates the conditions for increasing output without introducing significant additional capacities in spinning mills and improving the quality of raw materials, improving the quality of products and increasing labor productivity in knitwear factories. Therefore, the solution of the issue of lightweight knitted fabrics knittingwithout reducing it's the quality indicators is in line with the main directions of the development of the knitting industry.

For its implementation, scientists, together with employees of knitwear enterprises, develop new assortments of knitted goods with reduced material capacity, as well as technological modes for processing new types of raw materials, find new ways to further increase productivity, increase output of excellent quality, seek opportunities to maximize raw material and material savings and reduce cost of products.

II. REVIEW OF THE KNOWN WORKS

In work [1] it is noted that at the present stage of intensification of knitting production, the creation of fabrics with reduced raw material capacity is carried out in three directions: the development of double lightweight knitted fabrics on double needle bar machines; the development of single knitted fabrics on single knitting machines and the development of single lightweight fabrics on double needle bar machines.

I. I. Shalov [2] formulated the main direction for the economical use of raw materials in the production of knitted fabrics - the use of single knitted stitches instead of double ones, the use of yarns of reduced linear density, knitting of fabrics with float stitches.

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Lightweight fabrics can also be knitted by combining a two-color float jacquard with elements of other stitches, for example, inlay [3]. In this case, a high-volume yarn is laid on every fourth needle, creating the effect of a loose structure. This interlacing provides a reduction in material consumption by 35%.

Combined knitwear, as a rule, has a greater volume density than their base stitch (rib, interlock). This is often an obstacle to its wide application. Therefore, it is advisable to consider ways to reduce volume density while maintaining other advantages of combined knitwear [4].

One way to reduce the volume density of combined knitted fabrics is to miss the wales (exposing the needles), since this reduces the length of the thread used to form one loop course with a slight change in the width of the knitted fabric.

In [5], in order to expand the range of knitted fabrics, to improve the quality of double knitted fabrics and to maximize the technological possibilities of the circular knitting machine of the "SsangYong" type, four variants of combined knitted fabric on the basis of an rib stitch were developed and knitted, using cotton yarn with a linear density of 20 tex.

Among combined knitted fabrics, the greatest application is knitwear, combining elements of single and double stitches.

In conclusion, the authors note that due to the inclusion in the structure of the rib knitted fabrics of plain and purl stitches courses, achieved decrease in volume density, a higher form stability and an improvement in the quality of knitwear.

III. NEW WAY OF MATERIAL CONSUMPTION REDUCING

In the presented work, in order to reduce the consumption of raw materials in the production of double-layer knitwear, it is proposed to include in its structure inlay yarn.

In order to expand the assortment, reduce the consumption of raw materials and increase the form-stability of double-layer knitwear; four variants of inlay double-layer knitwear were developed on the flat knitting machine of class 14 PROTTI-242, which differed from one another in the way of fastening the inlay yarn in the ground structure.

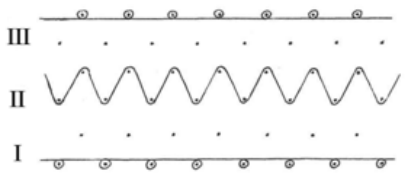
IV. EXPEREMENT RESULT AND DISCUSSING

To compare the technological parameters and the physic-mechanical properties of the samples of inlay double-layer knitted fabrics as a basic stitch double-layer knitwear, where the layers were knitted by plain stitch is used (I-variant).

In figure 1 graphical records of the inlay double-layer knitted fabric`s samples are shown. As raw material for the ground yarnwas used cotton yarn with a linear density of 20 texx 3, for inlay yarn - cotton yarn with a linear density of 20 texx 1; for connecting - high-stretch lycra thread with a linear density of 7.8 tex.

Technological parameters and physic-mechanical properties of the samples were determined by the standard procedure [4, 6] in the laboratory "CENTEXUZ" at Tashkent institute of textile and light industry, the results are given in Table.

I-variant



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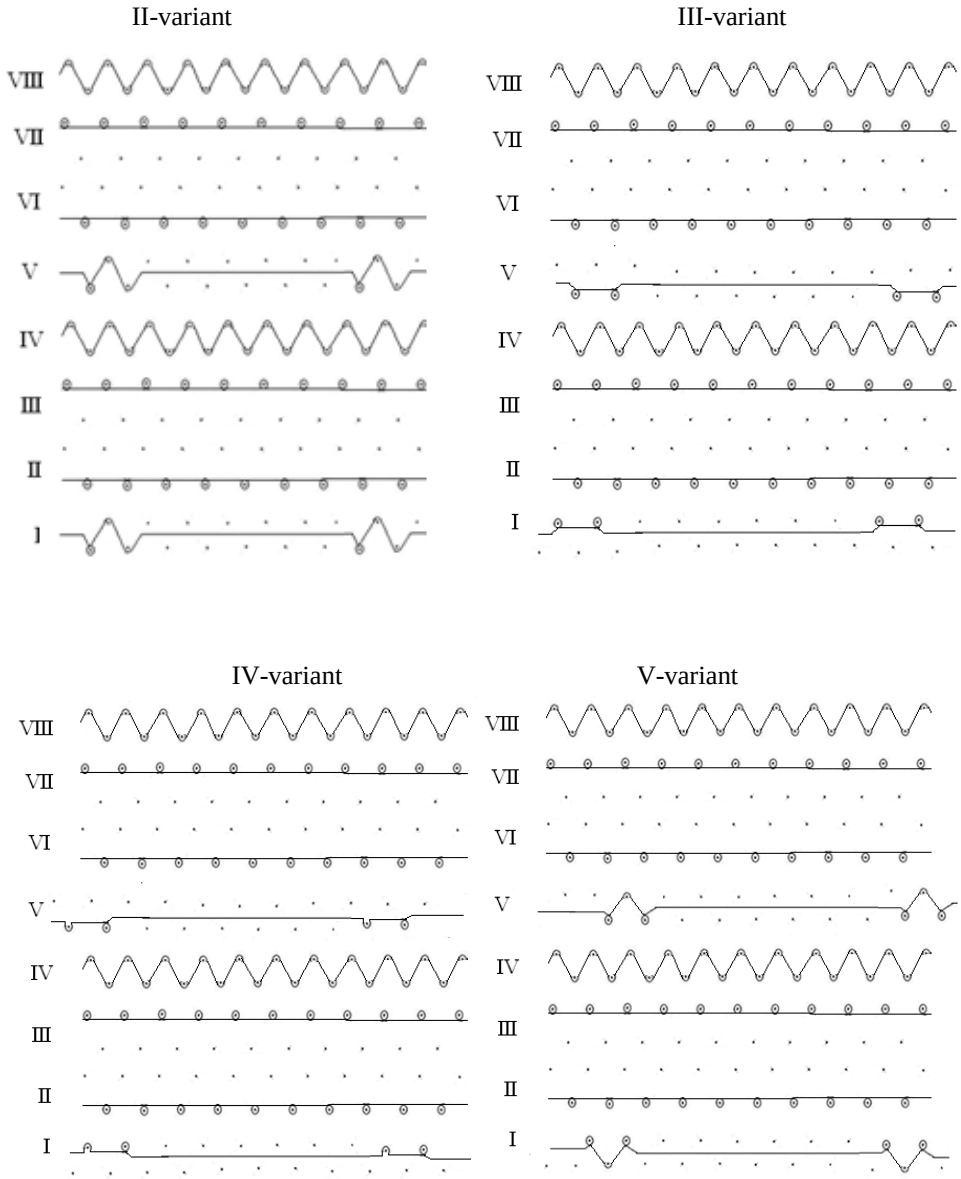

Fig. 1. Graphical records of samples of inlay double-layer knitted fabric

The criterion of material consumption is traditionally considered the surface density of the fabric. As is well known, a decrease in the surface density of knitwear entails a change in the operational and hygienic characteristics. Therefore, the volume density index is introduced, which simultaneously characterizes both the material capacity of the fabric and its quality indicators.

The bulk density of knitwear shows the content of textile threads per unit volume. When using volume density as a criterion for lightweight of knitted structure, the concept of "lightness" is expanding.

Table

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Indicators of technological parameters and physic-mechanical properties of knitted fabrics

Variants		I	II	III	IV	V
Surface density Ms, g / m^2		467,2	466,7	488,9	511,3	498,6
Thickness T, mm		1,32	1,5	1,55	1,58	1,59
Volume density δ, mg / cm^3		353,9	311,2	315,4	323,6	313,6
Air permeability B, cm^3 / cm^2sec		76,2	69,1	67,4	70,2	70,8
Breakingload P, H	bylenght	476,1	467,8	429,3	419,8	435,1
	inwidth	394,2	288,4	292,6	276,3	256,7
Elongation of jersey at 6 N,%	bylenght	6,2	7,1	6,9	5,8	6,0
	inwidth	18,9	13,1	12,6	11,4	12,8
Theirreversibledeformationεn%	bylenght	8	11,4	10,7	9,9	8,7
	inwidth	12	21	19	18	19
Reversibledeformationεo,%	bylenght	92	88,6	89,3	90,1	91,3
	inwidth	88	79	81	82	81
Shrinkage U,%	bylenght	10	5	7	5	5
	inwidth	2	4	9	-2	-2
Abrasionresistance, thousandobor.		More than 30000	Morethan 30000	More than 30000	More than 30000	More than 30000

At the same time, in the category of fabrics with reduced material consumption, fabrics with a loose structure are included, which have a considerable thickness, in comparison with the base one.

Comparing the volume density of double-layer knitted fabrics of different structures, we can see that the presence of inlay yarn in the structure of a double-layer knitwear not only reduces the volume density, but also increases the form-stability of knitwear.

In comparison with the base stitch (I-variant) the volume density of the II-variant of the inlay double-layer knitwear decreases by 12.1%, of the III-variant by 11%, of the IV-variant by 8.4% and of the V-variant of the inlay double-layer knitwear decreases by 11.4%.

The inclusion of inlay thread in the structure of double-layer knitwear leads to a change in the physic-mechanical properties of double-layer knitwear.

The main physic and mechanical properties of knitted fabrics are the characteristics that determine their scope of use.

The air permeability of the experimental samples of the inlay double-layer knitwear decreases in comparison with the base stitch, it leads to the increasing of heat-saving properties of knitwear.

Among the samples of inlaydouble-layer knitted fabrics, the least air permeability is possessed by the experimental III-variant (Table).

A significant characteristic of textile fabrics are semi-cycle tensile properties. All standards and specifications for textile fabrics include norms for tensile loads. As we know, the amount of tensile force per each loop depends on the number of loop elements participating in the break.

Applying to the sample the load and stretching it to the rupture, establish the strength and breaking elongation, which are one of the basic mechanical properties of knitwear, regulated by State standards. The tensile strength is characterized by the magnitude of the breaking load, i.e. the greatest effort; withstand a rectangular pattern of knitwear of standard size at the time of rupture.

Indicators of tensile loads for knitted fabrics are standardized. The discrepancy of the actual value of the tensile load indicates the poor quality of the knitwear. Strength indices are the main criterion for assessing the mechanical

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properties of knitted fabrics, despite the fact that the efforts they experience in the sewing and wearingprocess make up only a small part of the tensile forces.

Strength and elongation of knitted fabrics are determined mainly by the structure of the fabric itself, i.e. the kind of weaving, the density of knitting, the way and modes of finishing. The structure and properties of the fibers and filaments that form them greatly influence the mechanical properties of materials. The strength of knitwear depends on the number of threads resisting the tensile forces in each loop or column, the strength of the thread and the density of the fabric.

The strength of knitwear in the direction of the loop rows is determined by the resistance value of the tensile forces of the yarns connecting wales. Hence, the strength of the horizontal depends on the number of loop rows per unit length, i.e. density along the vertical and the number of threads in each row of the front and back layers of double-layer knitwear. The strength in the direction of the wales is determined by the resistance exerted by the filaments of the columns of double-layer knitwear, in each loop of the column of double-layer knitwear there are two branches, then in the two stitches, there are four loop sticks.

The breaking load of the samples of the inlay double-layer knitted fabric varies in length from 419.8-467.8 N and is close to the discontinuous loads of the base stitch (I-variant).

Breaking load on the width of the samples of the inlay double-layer knitwear varies within the limits of 256.7-292.6 N, i.e. much less than the breaking load of the base stitch (I-variant) (Table).

This is because when we stretch the inlay double-layer knitted fabrics along the width, the inlay yarns before the ground reaches the maximum stretched state and their rupture occurs, while the ground loops are still stretched due to the movement of the thread from the stick of the loops into the broaches. Thus, inlay threads mainly perceive the breaking load, and the ground threads are partially perceived (due to friction between the inlay and ground threads) the load is negligible in magnitude.

Therefore, in dull double-layer knitwear, the strength in width depends on the strength of the inlay yarn.

The indices of elongation at loads less than discontinuous are of particular importance to characterize the operational properties of products from a light-stretch fabric to reveal the limits of tapering in the design and cutting of articles.

The index of stretch ability of knitted fabrics is in the range of 20-200%. The stretch ability of cotton cloths from circular knitting machines varies between 50-150%, depending on the linear density of the thread, the kind of stitch, the class of the machine. In view of this indicator, when designing products, appropriate corrections are made to the dimensions of products, determined based on anthropometric data.

All knitted fabrics, depending on the index of extensibility, are divided into three groups. The first group includes cloths with an extensibility index less than 40%, to the second - with an extensibility index from 40 to 100% and to the third - more than 100%.

As can be seen from the analysis of physic and mechanical properties of knitted fabrics, the tensile elongation along the length of the proposed variants of a double-layerstitch knitted fabric is close to the values of discontinuous elongation of the base stitch (I-variant). The tensile elongation along the length of the II-variant of the inlaydouble-layer jersey is 7.1%, in the III-variant 6.9%, in the IV-variant 5.8%, and in the V-variant of the inlay double-layer knitwear 6% (Table). The discontinuous elongation along the width of the inlay double-layer knitwear is much less than that of the base stitch.

The discontinuous elongation along the width of the II-variant of the inlay double-layer knitwear is 30.7% less than the discontinuous elongation of the base stitch, in the III-variant it is less by 33.4%, in the IV-variant - by 39.7% less and in the V-variant less by 32.3% compared to the base stitch.

During operation, the fabrics in the products are abraded by surrounding objects touching them and because of wiping individual parts become unusable to wear.

As a criterion for assessing the durability of knitted fabrics for abrasion, the number of revolutions of the instrument is taken to rub the test specimen. Carrying out tests on the device and using this indicator as an evaluation criterion, we obtain the same characteristic of the compared samples as in the experimental wear.

The indicators of resistance to abrasion of knitted fabrics fluctuate within very wide limits - from 20 to 500 thousand revolutions of the device. Observations show that the relationship between the data of the experimental wear and the parameters of the instrument will be different for different products from the same kind of cloth, depending on their purpose.

The value of the abrasion resistance of experimental samples of a double-layer knitted fabric is close to the value of the abrasion resistance of the base stitch and is more than 30 thousand revolutions.

The values of reversible and irreversible deformation and shrinkage of the proposed variants of double-layer knitwear are close to the indices of the base stitch and meet the requirements of GOST [7].

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V. CONCLUSION

Analysis of the results of the study shows that the structure of the inlay double-layer knitwear contributes to a reduction in volume density, a decrease in stretch ability and shrinkage of knitwear, as a result of which form stability is improved, which positively affects the consumer properties of the developed samples of double-layer knitwear.

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AUTHOR'S BIOGRAPHY

Tamara Kalmuratovna Allamuratova Doctoral student of the Department of "Technology of textile fabrics" Tashkent Institute of Textile and Light Industry, 100100, Uzbekistan, Tashkent, St. Shohzhakhon-5

Mirabzal Miraubovich Mukimov D.Sc., prof. Department of "Technology of textile fabrics" Tashkent Institute of Textile and Light Industry, 100100, Uzbekistan, Tashkent, St. Shokhzhahon-5