About Technological Parameters of New Two-Layer Knitted Fabrics

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ABSTRACT: Reduction in the consumption of raw materials in knitting outerwear is actually problem of production. The article presents the results of a study of technological parameters and material consumption of new structures of two-layer knitted fabric. To study the technological parameters of new variants of two-layer knitted fabric on a Long Xing 252 SC flat-fanged machine, five variants of two-layer knitted fabric were developed, which differed from each other in the weave structure. By changing the structure of the layers of two-layer knitted fabric, it was achieved to obtain knitted fabric with specified properties and reduced material consumption.

I. INTRODUCTION

Expanding the assortment of knitwear is a major scientific problem, and the development of new stitches is one of the tasks in this area. To expand the range of knitted fabrics, it is necessary to identify those properties of materials that affect the improvement of the quality of knitwear when used for upper garments. The use of two-layer weaves in the production of knitwear allows varying parameters and properties in a wide range, however, the issue of material consumption of knitwear is very relevant.

The production of knitwear has characteristic advantages that open up broad prospects for the further development of this industry:

- in the field of expanding the range of products, there are inexhaustible possibilities of obtaining various two-layer weaves, providing knitwear with a wide variety of properties and appearance;

- valuable consumer properties of knitwear, which are characterized by a complex of physical and mechanical properties, such as high performance under conditions of repeated stretching, abrasion, crushing, etc., high hygienic properties (hygroscopicity, air capacity and a number of other properties that provide a comfortable feeling), a set of aesthetic indicators;

- wide technological capabilities, such as the manufacture of products in regular and semi-regular ways;

- high technical and economic indicators of knitwear production, which is due, first of all, to the high productivity of knitted machines, etc.

The renewal and expansion of the assortment usually follows several main paths, namely the renewal of raw materials, upgrading with modern finishes, fashionable color effects, etc.

However, the fundamental and most laborious way of updating the assortment is the development of new structures to provide new properties or higher quality indicators in accordance with the purpose, as well as for the formation of certain effects by creating certain elements in accordance with the tasks set.

II. LITERATURE REVIEW

The loop structure of knitted fabric is characterized by the fact that the filling of a unit of its area with threads is less than that of woven fabrics. As a result of this, knitted fabrics have a higher bulk (knitted fabric density 0.2-0.3 g / cm^3, woven fabric density 1.1-1.3 g / cm^3) [1]. At the same time, the consumption of threads in the production of a unit of area is dense by the knitted method is less than by the weaving one. This is one of the defining criteria for the advantages of the economics of the knitted production method.

The decrease in the material consumption of knitted products, in comparison with fabrics, is due not only to the structure of the material. Raising the class of knitting machines and the use of threads of low linear density is a

generally direction of reducing the consumption of raw materials. At present, cross-knitting machines of 28-32 class are widely introduced, models of machines of 42 class have been created.

For example, when switching from knitting fabric on 18 class machines to knitting it on 22 class surface density is reduced by 10-15%. Raising the class, as a rule, necessitates the use of threads of lower linear density (otherwise, the surface density of the material increases).

A further reduction in the consumption of raw materials can be achieved due to the inclusion of patterned stitch elements in the knitted fabric structure. Knitted fabric of patterned stitch is formed on the basis of the main or derivatives by introducing additional elements into them (tuck sketches, broaches, additional threads) or by changing the production processes, allowing to obtain knitted fabric with new properties.

The location of the loops in knitted fabric and the ties between the loops can be very diverse and are determined by the stitch of the knitted fabric [2].

The thread that forms the loop is in force interaction with the adjacent loops, due to which a certain shape and size of the loops, as well as the entire jersey, is preserved.

Knitted fabric in an equilibrium state does not tend to change in size and has a fairly high stability. However, after finishing the knitted fabric, its loop structure can come to a non-equilibrium state, which, in terms of the geometric parameters of the loops, will differ significantly from the equilibrium state. The stability of a fixed (non-equilibrium from the point of view of the force interaction of the threads) knitted fabric largely depends on the properties of the fiber (thermic plasticity) and the means of fixation used.

Along with the threads used for the manufacture of knitted fabric, stitch type is its most important characteristic and determines the properties of knitted fabric: extensibility, dissolving, surface density, thickness, dimensional stability, etc. Knitted fabric is characterized by a wide variety of stitch. By using different stitch, you can get knitted fabric with different properties, patterned or structured effects.

Currently, in the production of knitted fabrics and products, two-layer stitch are often used, which allow you to obtain all kinds of patterned effects and modify the structure and properties of knitted fabric. The knitted fabric of two-layer stitch is formed by a combination of main, derivative and patterned stitch. Such combinations can have an unlimited number of options, which depend on the purpose of the knitted fabric, the required properties and the patterned effect to be obtained.

Double layer knitted fabric can be obtained on all kinds of double knitting machines. Especially widespread use is found in double-layer knitted fabric from fang, purl and interlock machines.

The most rational way to improve the quality of knitted products is to use two-layer knitted fabrics, because in two-layer knitted fabric, you can combine various types of stitch, based on the set of properties that you want to give to the fabric being produced.

III. EXPERIMENT RESULTS AND DISCUSSION

To study the technological parameters of new variants of two-layer knitted fabric on a Long Xing 252 SC flat knitting machine, five variants of two-layer knitted fabric were developed, which differed from each other in the stitch structure. The raw material used cotton yarn of linear density 30 tex x 2 for one side of the two-layer knitted fabric and polyacrylonitrile (PAN) yarn of linear density 32 tex x 2 for the other side and for the weft thread.

When designing the threading of any new knitted fabric or knitted products, usually operate with such parameters as the loop step A, the height of the loop row B, the length of the thread in the loop *l*. The surface density of jersey and its properties depend on them. Knowing the dependence of properties on the parameters of the knitted fabric, you can choose the optimal machinethreading.

The two-layer knitted fabric of weft and warp-knitted stitch, various in structure, can satisfy the most varied requirements in relation to the parameters and indicators of properties that are presentedin the practice of manufacturing clothing and technical products.

The parameters of any knitted fabric are influenced by the properties of raw materials, the type of stitch and finishing.

At Figure 1 a graphical record of the production of two-layer knitted fabric is presented.
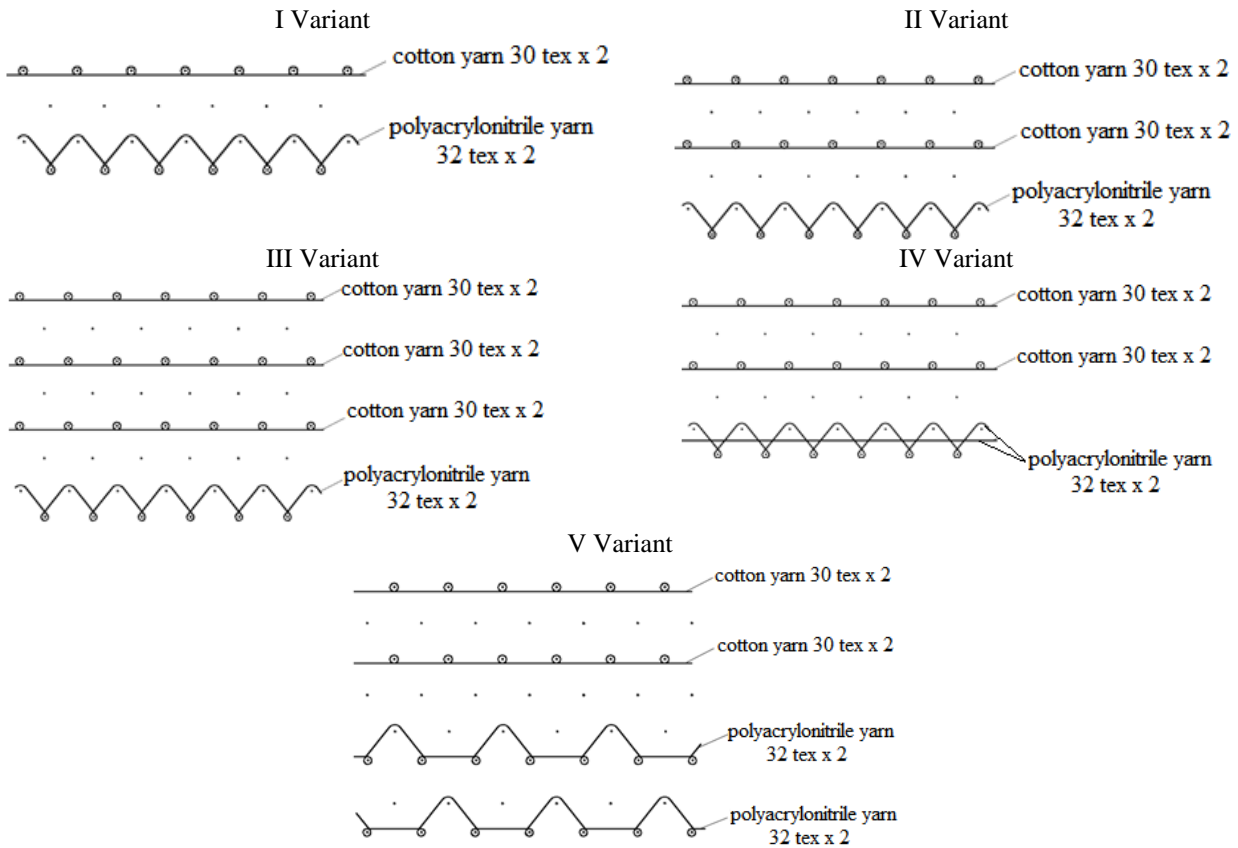
Fig. 1Graphical recording of the production of two-layer knitted fabric

For the basic option for comparing the parameters and properties of new options for two-layer knitted fabric, option I was adopted, developed on the basis of weaving of semi-fangs, where the press method of joining with warp threads is used to join the layers of knitted fabric. The technological parameters of two-layer knitted fabric were determined according to the standard method [3, 4] in the "CentexUz" laboratory at TITLI, the results are given in table.

Table 1
Technological parameters of two-layer weft knitted fabric

Indicators		Variants				
		I	II	III	IV	V
The content of threads in the fabric, %	Face layer	64,4	49	39	52	58
	Back layer	35,6	51	61	48	42
Loop width A, mm	Face layer	2,3	2,2	2,2	2,3	2,2
	Back layer	2,3	2,2	2,2	2,3	2,2
Hight of loop rowB, mm	Face layer	1,42	2,38	3,13	2,5	2,38
	Back layer	1,35	1,25	1,19	1,28	1,25
Horizontally density P_h loops in a 50mm by the course	Face layer	22	23	23	22	23
	Back layer	22	23	23	22	23
Vertically density P_v loops in a 50mm by the wale	Face layer	35	21	16	20	21
	Back layer	37	40	42	39	40
Length of thread in the loop	Face layer	16,54	16,46	16,18	16,36	10,8

l , mm	Back layer	6,95	6,92	6,56	6,88	6,7
Surface density M_S , g/m^2		508	370,7	374,4	389,4	459,3
Thickness T, mm		1,8	1,4	1,5	2,1	1,95
Bulk density δ, mg/cm^3		282,2	264,3	249,6	185,4	235,5
Absolutely bulk lightness $\Delta\delta$, mg/sm^3		-	17,9	32,6	96,8	46,7
Relative bulk lightness, θ , %		-	7	12	34	17

Two-layer knitted fabric consists of two identical or two different single fabrics, one of them may have different parameters from the other. This determines the interaction of the layers. One layer, when connected to another, can change its initial parameters, and the other, in turn, change the parameters of the first. Therefore, the density and length of the threads in the loops of the layers of two-layer knitted fabric cannot be determined using the corresponding formulas for single stitch. In addition, these parameters depend on the type and method of connection [5-8].

The technological parameters of knitted fabric can be determined in three ways:

1. According to standards. This method can be used when it is not required to determine the parameters of knitted fabric by calculation (for example, when calculating the weight of finishing parts, liners, erasers, etc.) or when the technological parameters of knitted fabric, established according to existing calculation formulas, have significant deviations from the actual indicators (for example, when determining the parameters of knitted fabrics of new stitch or made from new types of raw materials).But standards do not cover all types of threading and stitches.

2. Experimentally by threading. This method is most often used in research projects related to the development of new knitted fabricstitch. This method requires the availability of the necessary equipment, raw materials, etc.

3. Calculation method. This method can be applied in all design cases. The sequence of calculating technological parameters depends on the method adopted for calculating the loop length l [9-12].

The indicators characterizing the structure of knitted fabrics are: surface and bulk density, density (number of loops per unit length) in the longitudinal and transverse directions, thread length in the loop, skew angle of loop rows and loop stitches, knitted fabric thickness.

An analysis of the results of studies carried out by many scientists showed that a decrease in the surface density of knitted fabric within certain limits leads to a decrease in the consumption of raw materials and is less dangerous for its strength properties, since the absolute value of the strength of knitted fabrics is high, and during operation, the products are subjected to loads not exceeding 20% of breaking loads.

The criterion for material consumption is traditionally considered the surface density of the fabrics. A decrease in the surface density of knitted fabric entails a change in the operational and hygienic characteristics. Therefore, an indicator is introduced, which simultaneously characterizes both the material consumption of the fabrics and the quality indicator. Such an indicator is an indicator of the lightness of the structure of knitted fabric, in which, along with the surface density, its thickness is also taken into account [13, 14].

An indicator of the lightness of the structure of knitted fabric can be used for bulk density:

where, is the bulk density of the knitted fabric, mg / cm^3;

MS - knitted fabric surface density, g / m^2;

T - jersey thickness, mm.

The results of the study showed that the bulk density of the recommended samples of two-layer knitted fabrics is less in comparison with the basic stitch (option I) (Table 1, Figure 1).

If the areal density of the base stitch is Ms = 508 g / m^2 and the thickness is T = 1.8 mm, its bulk density is δ = 282.2 mg / cm^3.

In this case, the indicators of the absolute volumetric relief of the fabrics in comparison with the base stitch will be as follows:

$$\Delta\delta \;= \delta_{\it{б}} - \delta \;= 282,2 - 264,3 = 17,9 \, mg/cm^3 \quad \text{(II var.)}$$

$$\Delta\delta \;= \delta_{\it{б}} - \delta \;= 282,2 - 249,6 = 32,6 \, mg/cm^3 \quad \text{(III var.)}$$

$$\Delta\delta = \delta_{\delta} - \delta = 282{,}2 - 185{,}4 = 96{,}8\,mg/sm^3 \text{ (IV var.)}$$

$$\Delta\delta = \delta_{\delta} - \delta = 282{,}2 - 235{,}5 = 46{,}7\,mg/cm^3 \text{ (V var.)}$$

Here:

$\Delta\delta$ - volumetric ease, mg / sm³;

Δb - bulk density of the base variant, mg / sm³;

δ - bulk density of the investigated variant mg / sm³;

Relative lightness is determined by:

The relative lightening of the manufactured samples of two-layer knitted fabric is as follows:

$$\theta = (1 - \frac{\delta}{\delta_{\delta}}) \cdot 100\% = (1 - \frac{264{,}3}{282{,}2}) \cdot 100\% = 7\% \text{ (II var.)}$$

$$\theta = (1 - \frac{\delta}{\delta_{\delta}}) \cdot 100\% = (1 - \frac{249{,}6}{282{,}2}) \cdot 100\% = 12\% \text{ (III var.)}$$

$$\theta = (1 - \frac{\delta}{\delta_{\delta}}) \cdot 100\% = (1 - \frac{185{,}4}{282{,}2}) \cdot 100\% = 34\% \text{ (IV var.)}$$

$$\theta = (1 - \frac{\delta}{\delta_{\delta}}) \cdot 100\% = (1 - \frac{235{,}5}{282{,}2}) \cdot 100\% = 17\% \text{ (V var.)}$$

As can be seen from Fig. 1, the smallest consumption of raw materials in the production of two-layer knitted fabric is required for the fourth version of knitted fabric, i.e. the bulk density of knitted fabric is the lowest compared to other variants. The bulk density of knitted fabric varies in a very wide range, depending on the type and size of the threads used, their density, class and type of machines and stitch.
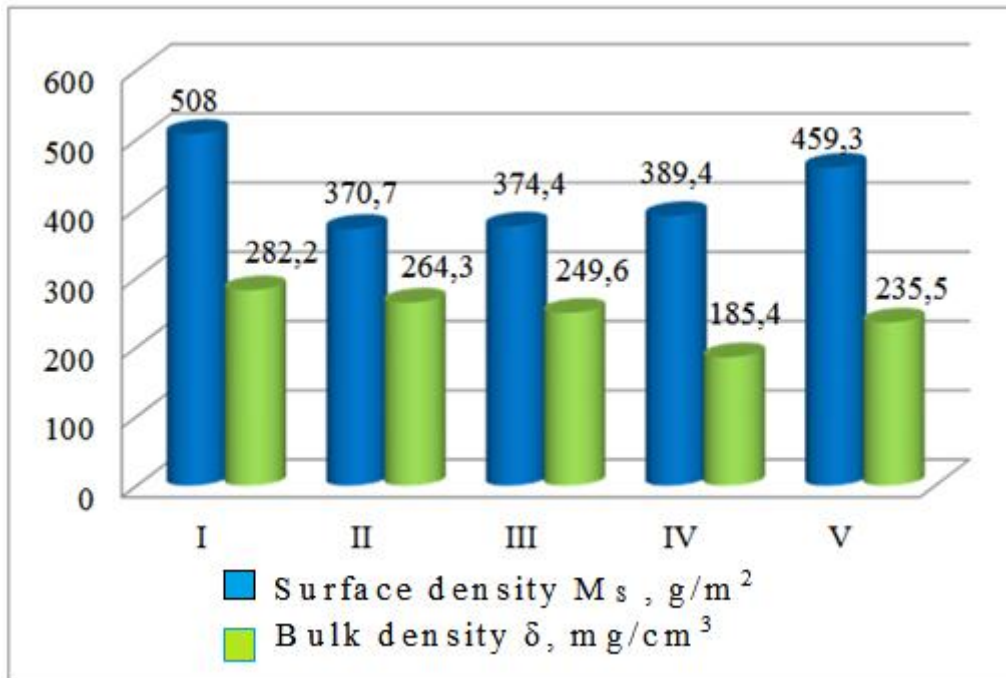

Fig. 2 Histogram of changes in surface and bulk density of two-layer knitted fabric

Changes in the structure of the seamy layer of two-layer knitted fabric, where in the repeat of fabric instead of one plane row (variant I), three plane loop rows are formed (variant III) have a significant effect on the parameters and, first of all, on the surface density and thickness of the knitted fabric (Fig. 1,2).

A decrease in the consumption of raw materials in the production of II, III variants of two-layer knitted fabric, compared to the basic stitch (I variant), is achieved by increasing the number of plane stitch rows of the repeat on the seamy side of the fabric. In the IV variant of two-layer knitted fabric, a decrease in the consumption of raw materials is achieved by increasing the number of plane rows in the stitch rapport and the inclusion of a weft thread in the knitted fabric structure.

Thanks to the proposed structure of knitted fabric, it becomes possible to increase the volume and thickness of the knitted fabric and reduce the extensibility in width, and therefore, to solve the problem posed - to create a two-layer knitted fabric with increased dimensional stability. In addition, the use of this solution will reduce irreversible deformations of finished products, and therefore, expand the application area and assortment of knitted fabric.

When the V variant of a two-layer knitted fabric a decrease in the bulk density of the knitted fabric is achieved by changing the methods of joining the layers of the two-layer knitted fabric.

I=1,8 mm

II=1,4 mm

III=1,5 mm

IV=2,1 mm

V=1,95 mm

Fig. 3Thickness of two-layer knitted fabric

IV. CONCLUSION AND RECOMMENDATION

According to the results of the study of the technological parameters of two-layer knitted fabrics, presented in the table, it can be noted that a comparison of knitted fabrics with each other in terms of surface density (Fig. 1) showed that the second version of two-layer knitted fabric has the lowest surface density, and a comparison of samples in terms of bulk density showed that the lowest bulk density is possessed by the IV variant of two-layer knitted fabric, because the thickness of the IV variant of the knitted fabric is greater than that of the other variants.

In conclusion, it can be noted that by changing the structure of the layers of two-layer knitted fabric, it is possible to obtain knitted fabric with specified properties and reduced material consumption. The developed two-layer knitted fabrics can be successfully used for the manufacture of upper and children's assortment.

REFERENCES

[1]. Tsitovich I.G. Technological assurance of the quality and efficiency of knitting processes in cross-knitted jersey. M .: Legprombytizdat. 1992, 240 p.

[2]. Shalov I.I. Combined knit stitch. M. MTI. 1971, p. 23.

[3].Torkunova Z.A. Knitted fabric tests. -M .: Light industry, 1975, -224 p.

[4]ShustovYu.S. Fundamentals of Textile Materials Science. -M .: OOO Sovyazh Bevo 2007 - 300 p.

[5]. Patent No. 9405770 (France), MPK6 D 04 B 7/04. A method for producing a two-layer knitted fabric. Thevenet Bruno. Protecma (S.a.2.1) Application No. 2719606. Appl. 05.05.1994. Publ. 10.11.1995.

[6]. Patent No. 6089052 (USA), IPC7 D 04 B 21/00. Riegger Stephen No. 09/136150. Appl. 18.08.1998. Publ. 07/18/1996. NPK 66/195

[7]. Patent No. 6194332 (USA), IPC7 B 32 B 15/00 D 04 B 1/16. Malden Mills Ind, Inc. Rock Moshe, Lumb Douglas, Lie William K. No. 09/219920. Appl. 12/23/1998. Publ. February 27, 2001. NPK 442/312.

[8]. Patent No. 2288980 (Russia), IPC D 04 B 1/00. Two-layer jersey. G.A. Bronze, V.S. Kulikov. Appl. April 15, 2005. Publ. 10.12.2006.

[9]. Kudryavin L.A. Fundamentals of knitting technology. M .: Legprombytizdat, 1991 340 p.

[10].Shalov I.I. and other technology of knitted fabric production. M .: "Light and food industry", 1984. 294 p.

[11].Shalov I.I., Dalidovich A.S., Kudryavin L.A. Knitted fabric technology. M .: Legprombytizdat, 1986 375 p.

[12]. Dalidovich A.S. Foundations of knitting theory. M. "Light Industry", 1970.431p.

[13]. Yunusov K.Z., Khankhadzhaeva N.R., Mukimov M.M. Development of structures and methods for the production of knitted fabrics on a circular knitting machine. // "Infotekstil-2005". Implementation of information communication technologies in the textile and light industry. Collection of articles rep. Scientific and practical Conf. - Tashkent: TITLP, 2005.65-66 p.

[14].Hanhadjaeva N. Producing of interlock structures on circular knitting machine. // Safety and quality of food and consumer goods: Conference proceedings. - Almaty: Almaty Technological University, 2009, 126-128 p.