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Investigation of Knitting Structures Parameters for Shoe Upper

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ABSTRACT. In this research work the technological potential of the flat knitting machine was studied and new knitted fabric structures for shoe upper based on complex structures were created. Technological parameters of knitted fabrics obtained at the enterprise were studied. Parameters and properties were determined experimentally. All knitting patterns were developed under the same conditions in one machine using PE yarns. The results of the analysis of the technological parameters of the fabric show that the additional elements included in the fabric also affect its properties. Changing all the parameters in a certain direction in width and length can increase or decrease this or that feature. Therefore, such knitted fabrics can also be recommended for the production of knitted products with high shape stability properties. Such knitted fabrics are recommended for the production of knitted products for functional purposes, in particular, for the upper part of shoes.

KEY WORDS: Flat knitting machine, needle, loop, structure, technological parameters, experiment, shoe upper knitting, length, density, thickness.

I.INTRODUCTION

The knitting industry occupies one of the leading positions in the world. The range of products is expanding, and the demand for them is growing rapidly. At the same time the high level of competition for knitted products in the world market requires investigation of technological possibilities of equipment that allows for rapid changes in terms of quality and quantity of modern improved technologies. It is important to obtain high-quality and competitive products and to further improve the quality of knitting products.

In the world, scientific and research work is being carried out aimed at the development of new scientific and technical solutions of resource-efficient technologies and technical means for obtaining complex knitted fabric structures. In this regard, special attention is paid to the justification of technological processes, parameters and working modes of functional knitted products used for special purposes along with knitted products used in everyday life.

Today, there is a high demand for functional knitwear, a product that stands out with its appearance. Therefore, shape stability properties, high physical-mechanical properties, low consumption of raw materials and high quality allow to expand the possibilities of knitting machines, as well as to regularly change the assortment and adapt to market demand, to reduce the replacement costs for updating new equipment. The desired results are achieved by adding additional elements to structure or changing the production process based on the basic and derived structures of knitted fabrics [1-3].

II.RESEARCH METHODS

Several sources have been explored for the development of new knitted fabric structures for experimental research [4-7]. For example, they provide information on the seamless technology of breathable shoes. The "Moderam" enterprise (Russia) has launched the production of protective footwear based on this technology. According to another source, scientists from the University of California have created fully biodegradable shoes, the upper part of which is made of 3D knitted fabric from plant fibers, and the sole part is made of ecological foam polyurethane. A product made from such raw materials is 100% biodegradable. At the same time, extensive information about LONG XING flat knitting machines

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with double needle bed is presented, and the possibilities of such machines are revealed. The types intended for the production of shoe uppers are discussed separately. This machine has rapid carriage return, dynamic density control, and tight tuck function equipped with high position roller taking down system and latest crossing sinker pressing system which make the pattern of shoes upper structure more abundant and strong 3D effects. Adjustable tight tuck device can fully meet the special needs of the loose or tight tuck structure of the shoe upper, independent pushing needle cam control mechanism, shorten the carriage return time, High-performance servo control technology, the machine's running position is more accurate, and the return is faster. Programming system is more intelligent and modularized. Operation and production are easier. Suitable for chemical fiber and nature fiber and other mixed material to knit. It should be noted that some kind of these machines have their place in the market of Uzbekistan. A number of enterprises that regularly produce knitwear products have installed such machines and are now working efficiently.

Materials on technological parameters of knitting, their changes and effects on properties were also reviewed [8-10]. In particular, bases of textile material sciences, knitted fabric specification and influence of machine parameters to knitting parameters, definition of knitting parameters and etc. It is necessary to continue research-investigations and definition of knitting structure parameters and compare to each other and make conclusions.

The manufacture of shoe upper products based on knitted structures is a new direction in the field of textiles in Uzbekistan. We have recently begun to study and conduct research in this area. Several theoretical and experimental works have been carried out on the study and research of structures. Today, we are also interested in the wide use of knitted structures in shoe industry. For this, different variants of samples were made from special raw materials. This article describes the experiment of obtaining samples and the results of the technological parameters.

III.EXPERIMENTAL RESULTS

At present, several variants of knitted structures on LONG XING flat knitting machines for a different range of knitted products have been developed and studied, the results have been published in various publications [11-14]. In this research paper, variants of complex structures are developed and recommended for use as shoe upper part. Figure 1 shows an example of one of knitting samples created for shoe upper (notation and front side of structure). Experiments were carried out on a double needle bed knitting machine LONG XING, installed in the conditions of the knitting factory in accordance with the rules of production of knitted fabrics. Possibilities of obtaining knitted fabrics on modern flat knitting machines were studied. Spire parts and machine productivity were analyzed.

As a result of the study, it was found that there is a possibility to produce a wide range of knitted products based on the capacity of the machine and the work productivity is high. Knitting variants of new complex structure for shoe upper were created and developed. Rapport of knitting structure in notation that is shown in fig.1 consists of 11 courses. Rapports of variants may include different elements of knitting structure both simple loop and such as half loop, transferred loop, elongated sinker loops, different knitting elements in front and rear needle bed. May be knit full course or not full course that means not all needles are made loops like spacer fabric structures. Therefor machine has to have possibility of selection of needles at the interloopings process.

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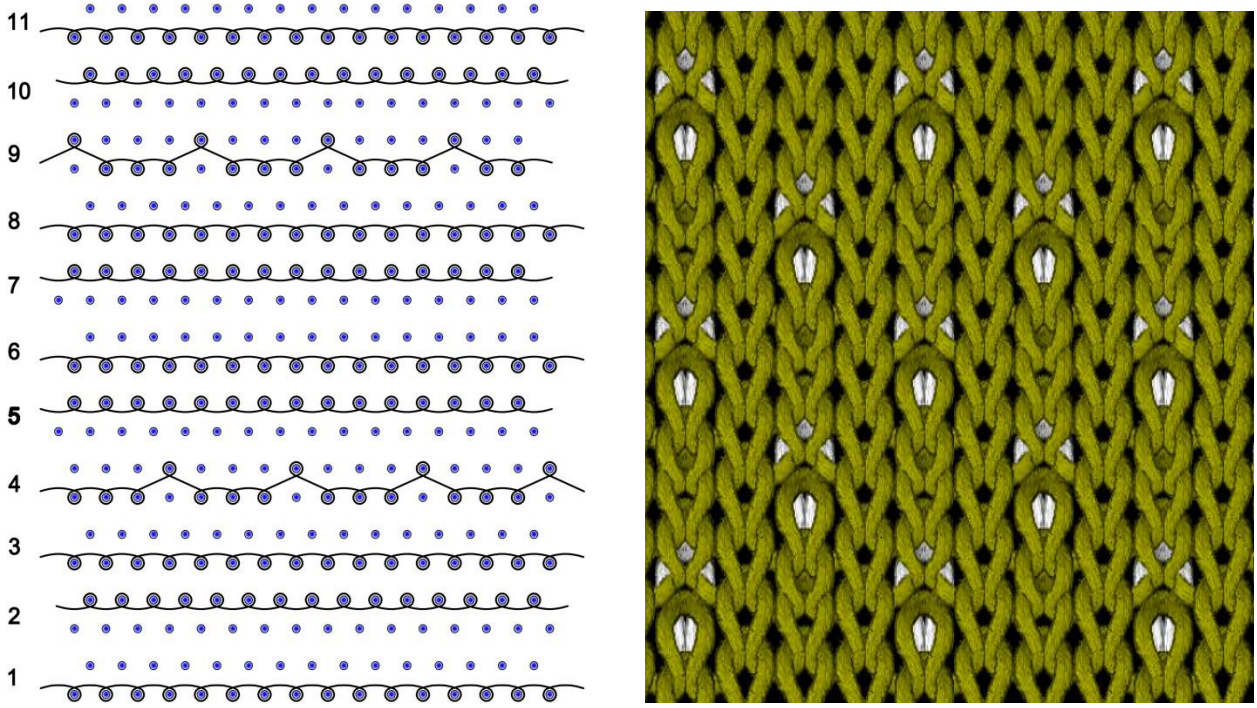

Fig.1. Example of knitting sample for shoe upper (notation and front side of structure)

Such shoe upper is made on a knitting machine and in finished form is knitted from the necessary yarns. The main difference between such a fabric and ordinary woven fabric is that the yarns do not intersect inside the fabric, but form loops. Therefore, knitted fabric is stronger and more elastic than fabric made on weaving looms.

The programmable machine allows creating any given pattern and knitting structure in various parts of the upper. In addition to the appearance and design solutions, this feature also provides functional advantages: it allows strengthening the parts due to tighter knitting and making the places on the upper part more breathable due to knitting with holes.

Technological parameters of the newly created knitting variants were analyzed. The results obtained are presented in table 1, which are analyzed for each parameter and described in the text.

IV. RESULTS AND DISCUSSION

Technological parameters such as loop width A (mm), loop height B (mm), horizontal density P_g, vertical density P_v, loop length L (mm), surface density m_{gr}, thickness M, volume density δ identified and included in the table1.
If the results are analyzed, one of the technological parameters the loop width of knitted variants varied basically in the range of 1.42–1.6 mm (11%). The height of the loop of knitted variants varied in the range of 0.72–1.04 mm (30%).

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Table 1
Technological parameters of the knitting variants

Variants	Width of loop, A (mm)	Height of loop, B (mm)	Horizontal density,P_g,	Vertical density,P_v,	Length 0f loop, L (mm)	Surface density m_{gr} (g/m^2)	Thickness, M (mm)	Volume density, δ, mg/sm^3
1	1.6	0.9	30	55	5.1	893	2.8	318.9
2	0.72	0.72	36	36	5.5	787	2.2	357.7
3	1.6	0.9	30	55	4.8	974	2.4	405.8
4	1.6	1.04	30	48	5.5	815	2.1	388
5	1.6	1	30	50	5.7	783.2	2.16	362.5
6	1.42	0.73	35	68	4.4	936.4	2.2	425.6
7	1.42	1.1	35	45	4.8	716.4	2.5	286.5
8	1.6	0.87	30	57	4.9	766.4	1.7	450.9

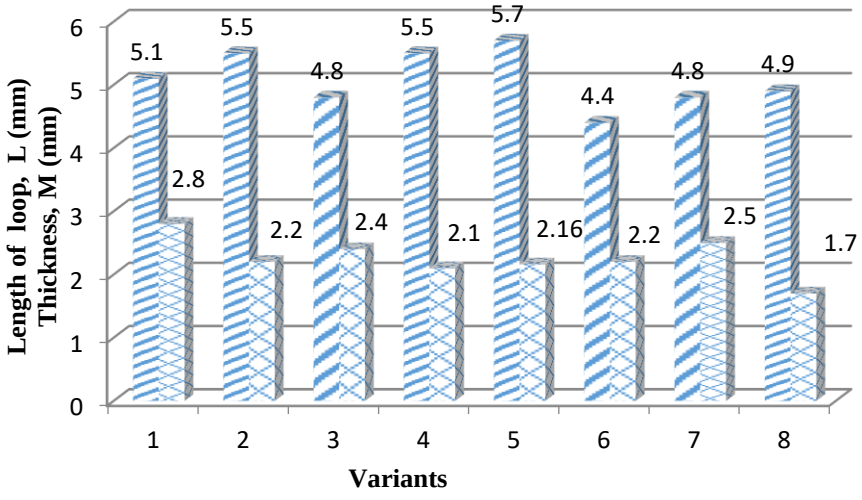

Fig.2. Diagram of Length of loop L and Thickness M.

The next parameter is the density P_G horizontally, the density P_V vertically. The density in the horizontal P_G consists of 30-36 loops in knitted fabrics, the density in the vertical P_V consists of 36-68 loops. The change in variants is 16-47%. As seen horizontal and vertical densities have large difference between each other. The reason for this are additional elements in the structure that may influence to change both parameters and properties like half loop, transferred loop, elongated sinker loops, different knitting elements in front and rear needle bed.
Length of the loop is important in the formation of knitwear (fig.2). To control of raw material expenditure length of the loop must be strong set and controlled. The length of the loop in the fabric is 4.4-5.5 mm (25% change).

The next parameter is the thickness of the samples. The thickness of the fabric (knitwear) depends on the thickness of the yarn forming it, the kind of knitting structure, the stitch density and finishing operations. In order to further determine the raw material used for knitted fabric, its thickness should also be taken into account. The thickness of the samples can

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also be determined under a special thickness measuring instrument under laboratory conditions. The thickness of the samples is 1.7–2.8 mm for variants and it is observed that it varies up to 39% .

The analysis of the surface density of the knitting samples shows that the surface density of samples is 716.4-974 g / cm^2, which is changing 26%. This depends on changes in structures that achieved by adding elements. Since the surface density is directly related to the raw material expenditure and the volume density is directly related to the knitting thickness, it is correct to estimate by this parameter (Fig. 3). The volume density ranged from 286.5 to 450.6, which is 36%. A 26% change in surface density resulted in a 36% change in volume density. The studied samples of knitted structures are produced from the same type of yarn with the same linear density. Therefore, the knitting structure maximally influences to the thickness.

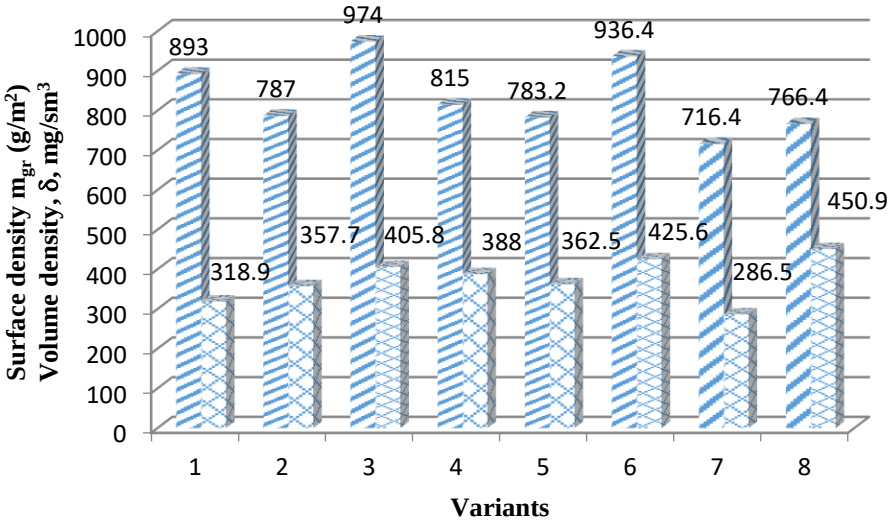

Fig.3. Surface density m_{gr}, Volume density, δ.

While surface density takes into account the width and height of the knitting, volume density is a parameter that takes into account both thickness and the width and length of the knitting. Therefore, a decrease in volume density indicates a decrease in raw material expenditure. The newly created knitted fabrics can be included in the category of resource-saving fabrics with reduced raw material consumption and they are offered to use for shoe upper parts.

V. CONCLUSION

In this research work the technological potential of the flat knitting machine was studied and 8 kind of new knitted fabric structures for shoe upper based on complex structures were created. The shoe upper is made on special knitting equipment with a programmable configuration pattern, complex fabric texture and upper design. The results of the analysis of the technological parameters of the fabric show that the additional elements included in the fabric also influent its properties.High lightness - knitted material is 2.5-3 times lighter than natural leather. High abrasion, tensile and tear strength because of using polyester yarns. Such knitted fabrics are recommended for the production of knitted products for functional purposes, in particular, for the upper part of shoes. Research investigation will be continued for analyzing of properties.

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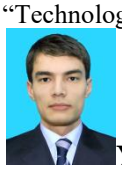

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