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Investigation of the structures of complex knitted fabrics

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Abstract

In this article technological possibilities of double bed flat knitting machines have been investigated to create complex knitting structures. Complex knitting structures have been created on the base of rib structures and loop transfer elements have been added into structure. Technological parameters and physical and mechanical properties of knitted fabrics obtained at the enterprise were studied. Parameters and properties were determined experimentally. Variants of complex knitting were developed and produced to observe different changes in technological parameters. In this work structures and notations of four variants are offered as complex knitting structure. The results of the analysis of the technological parameters of the fabric show that the pattern elements included in the fabric also affect its properties.

Key words. Double knitting machine, needle, flat needle bed, loop, loop transfer, structure, technological parameters, notation, properties.

Introduction

The world's leading manufacturers of knitwear are expanding the range of competitive products, producing highly environmentally friendly products using natural raw materials, applying new types of raw materials and processing methods, improving the quality of knitted products and reducing raw material consumption. In this regard, one of the important tasks is to create a technology for the production of low-cost knitted products with high retention of shape stability properties, using raw materials efficiently and changing the structure of the fabric.

The purpose of these measures is to meet the needs of the population in textile and light industry products, to improve the quality of products. The light industry, including the textile industry, plays a major role in meeting the material and spiritual needs of the people.

An increase in the output of modern knitwear, an improvement in their quality and an intensification of production require the improvement of the raw material base, rational and economical use of natural yarn, widespread use of chemical threads, since the cost of raw materials is 80-90% of the cost of the finished product. Therefore, it is planned to carry out work on the creation and implementation of knitted fabrics and products from them with reduced material consumption through the use of various lightweight structures, chemical threads, progressive technological processes and new modern equipment.

Methods

The basic requirements for rib loop transfer on any rib machine are: 1. Specially-designed latch needles with a ledge for lifting the delivering loop and either a recess or springs clip on the side of its stem to assist entry of the receiving needle hook into the spread loop. 2. A delivering needle cam that lifts the needle higher than normal clearing-height, lifting and spreading its loop so that the hook of the receiving needle can enter it as its cam lifts it to approximately tuck height. Normal needle selection arrangements can thus be employed to select those needles required to be lifted by the delivering needle transfer cam. 3. A needle bed rack of between 1/3 and 1/2 of a needle space so that the stems of the delivering and receiving needles are very close during the loop transfer action [1-6]. Fig. 1 illustrates the transfer action, together with its associated cam system. There is a receiving cam and a delivering cam in each needle cam system at the end of each system, thus providing the possibility of two-way loop transfer in the leading system in each direction of carriage traverse. The delivering needle cam has a double peak; the first peak lifts the loop to stretch and open it ready for transfer on the second peak. The receiving needle cam in the opposite bed is aligned with it and the under edge of, the delivering cam in its system acts as a guard cam for the receiving needle butts. In Fig. 1a, the delivering needle (b) is moving towards transfer height, with the receiving needle (a) about to enter the recess on its underside. At this point (Fig. 1b), a stop ledge (c) on the rising delivering needle (b) contacts and opens the latch of needle (a) (this arrangement is necessary for opening the latches of empty receiving needles). In Fig. 1c, needle (b) is cammed to full transfer height, lifting the loop to be transferred, and needle (a) is cammed into it with its hook open. In Fig. 1d, transference is completed by lowering needle (b) so that its loop is knocked-over and fully transferred into the hook of needle (a). Single-bed knitting is possible whilst the beds are racked for transfer.

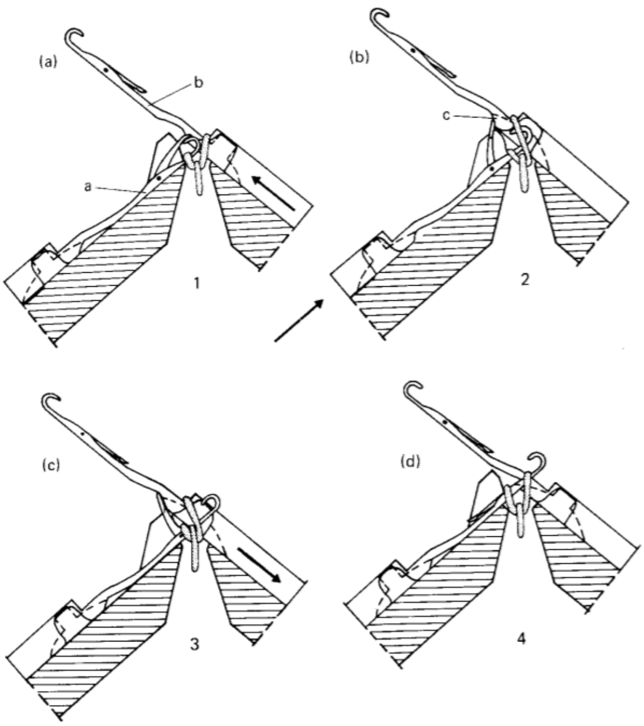

Fig. 1. Rib loop transfer on a modern V-bed machine.

In this research work, after investigation of the technological potential of the flat knitting machine technological possibilities were studied and new patterned complex knitted fabric structures were created [7-11]. Initially, pattern rapports of complex knitted fabric were created. Then, according to the pattern, knitting structures (Fig.2,4,6,8), graphic notations (Fig.3,5,7,9) were prepared. In order to achieve the pattern effect and improve the performance of the complex knitted fabric, spun cotton yarn, acrylic yarn, as well as polyester yarns were used 4 types of new knitted fabric samples of complex structure were produced from 3 different types of raw materials. The structure of the 1st sample is shown in the fig.2, the graphic notation is shown in the fig.3. Samples from 3 different types of raw materials for these variants were marked as 1.1, 2.1, 3.1. The structure of the 2nd sample is shown in the fig.4, the graphic notation is shown in the fig.5. Samples from 3 different types of raw materials for these variants were marked as 1.2, 2.2, 3.2. The structure of the 3d sample is shown in the fig.6, the graphic notation is shown in the fig.7. Samples from 3 different types of raw materials for these variants were marked as 1.3, 2.3, 3.3. The structure of the 4th sample is shown in the fig.8, the graphic notation is shown in the fig.9. Samples from 3 different types of raw materials for these variants were marked as 1.4, 2.4, 3.4.

Experimental work

The process of knitting of these variants is explained below in rows.

Sample 1 consists of 20 rows.
In row 1, only the front needle bed works, while the back needle bed is closed.
In row 2, only the back needle bed works and the front needle bed is open.
In row 3, the situation in row 1 is repeated.
In row 4, the situation in row 2 is repeated.
In row 5, the situation in row 1 is repeated.
In row 6, the situation in row 2 is repeated.
In row 7, the situation in row 1 is repeated.
In row 8, the situation in row 2 is repeated.
In row 9, the loops on needles 3-7-11 on the front needle are moved to the needles on the back needle bed.
In row 10, the selected needles in the front and back needles form a loop, then the loops in needles 4-8 in the front needle bed are transferred to the needles in the back needle bed.
In row 11, the situation in row 1 is repeated.
In row 12, the situation in row 2 is repeated.
In row 13, the situation in row 1 is repeated.
In row 14, the situation in row 2 is repeated.
In row 15, the situation in row 1 is repeated.
In row 16, the situation in row 2 is repeated.
In row 17, the situation in row 1 is repeated.
In row 18, the situation in row 2 is repeated.
In row 19, the loops on needles 5-9 on the front needle bed are moved to the needles on the back needle bed.
In row 20, the selected needles in the front and back needle beds form a loop, then the loops in needles 6-10 in the front needle bed are transferred to the needles in the back needle bed (Fig.2 shows the structure and graphic notation on Fig.3).

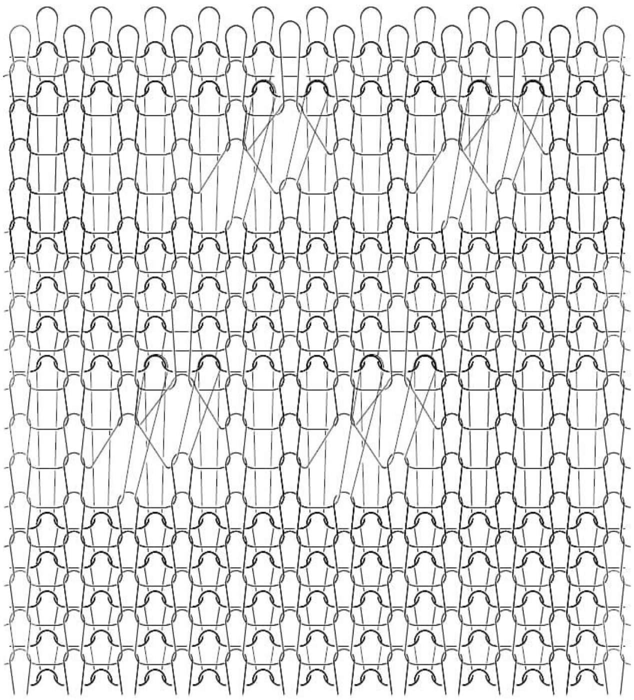

Fig.2. Structure of Sample 1.

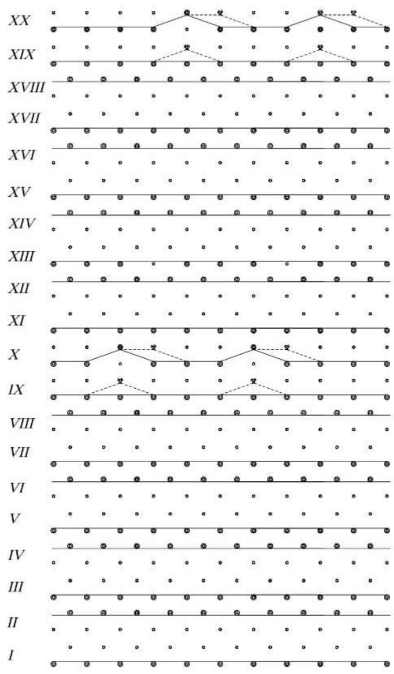

Fig.3. Notation of Sample 1.

Sample 2 consists of 12 rows.
In row 1, only the front needle bed works, while the back needle bed is closed.
In row 2, only the back needle bed is working and the front needle bed is open
In row 3, the situation in row 1 is repeated.
In row 4, the situation in row 2 is repeated.
In the 5th row, the yarn is feeding to even needles.
In row 6, the loops on the 2-4-6-8-10-12 needles on the front needle bed are moved to the needles on the back needle bed.
In row 7, the situation in row 1 is repeated.
In row 8, the situation in row 2 is repeated.
In row 9, the situation in row 1 is repeated.

In row 10, the situation in row 2 is repeated.
In the 11th row, the yarn is feeding to odd needles.
In row 12, the loops on needles 1-3-5-7-9-11 on the front needle bed are transferred to the needles on the back needle bed (Fig. 4-5 show the structure and graphic notation of sample 2).

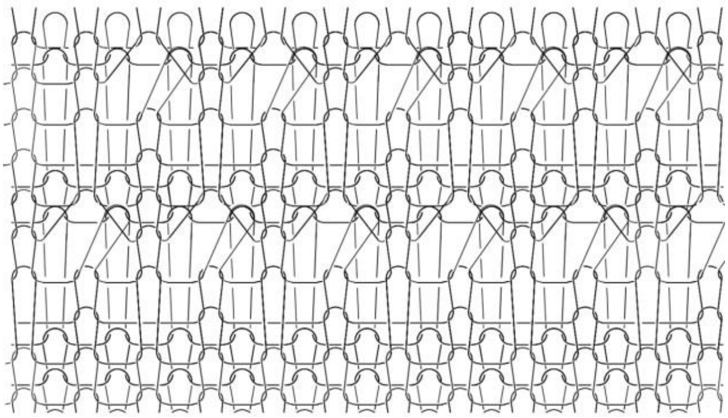

Fig.4. Structure of Sample 2.

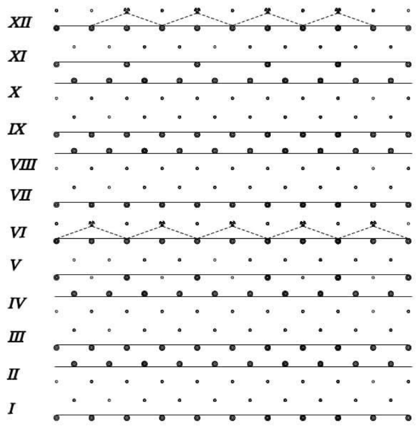

Fig.5. Notation of Sample 2.

Sample 3 consists of 10 rows.
In the 1st row, only the front needle bed works, and the back needle bed is closed.
In the 2nd row, only the back needle bed works and the front needle bed is closed.
In row 3, the situation in row 1 is repeated.
In row 4, the situation in row 2 is repeated.
In row 5, the situation in row 1 is repeated.
In row 6, the situation in row 2 is repeated.
In row 7, the situation in row 1 is repeated.
In row 8, the situation in row 2 is repeated.
In the 9th row, the loops on the 3-5-8-10 needles on the front needle bed are moved to the needles on the back needle bed.
In row 10, the selected needles in the front and back needle beds form a loop, then the loops in needles 4-9 in the front needle bed are transferred to the needles in the back needle bed (Fig. 6-7 show the structure and graphic notation of sample 3).

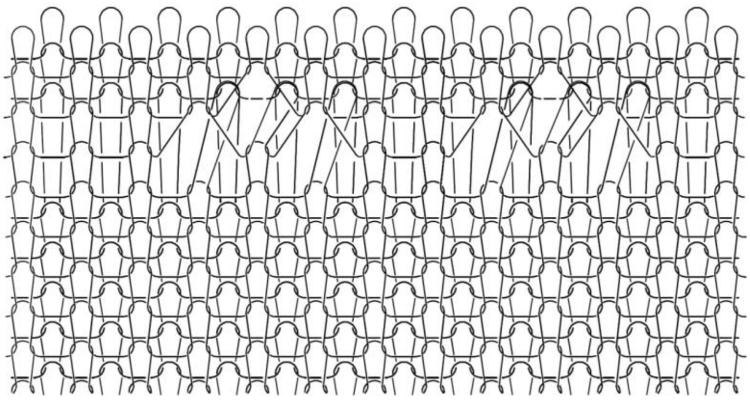

Fig.6. Structure of Sample 3.

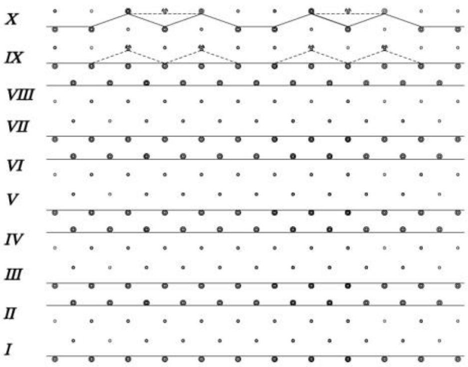

Fig.7. Notation of Sample 3.

Sample 4 consists of 7 rows.
In the 1st row, only the front needle bed works, and the back needle bed is closed.
In row 2, the loops on needles 5-11 on the front needle bed are transferred to the needles on the back needle bed.
In the 3rd row, only the back needle bed works and the front needle bed stands.
In row 4, the situation in row 1 is repeated.
In row 5, the selected needles in the front and back needle beds form a loop, then the loops in needles 3-9 on the front needle bed are transferred to the needles on the back needle bed.

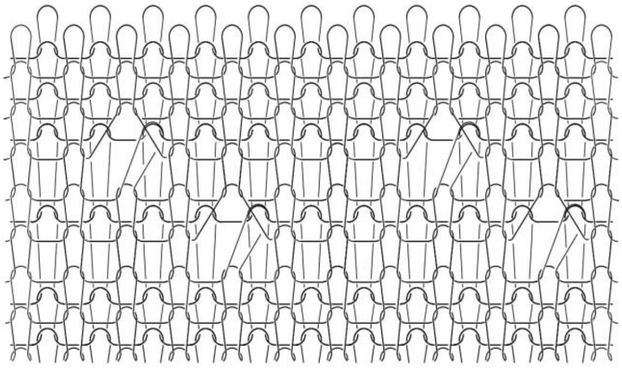

Fig.8. Structure of Sample 4.

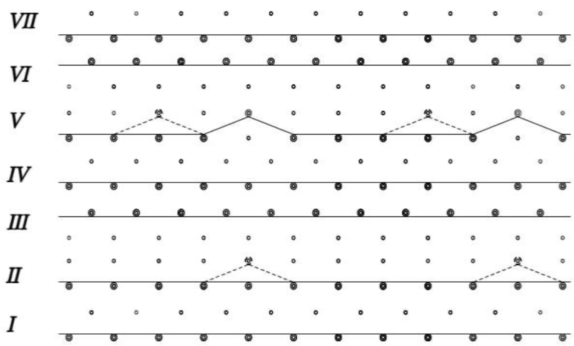

Fig.9. Notation of Sample 4.

In row 6, the situation in row 3 is repeated.
In row 7, the situation in row 1 is repeated.
(Fig. 8-9 show the structure and graphic notation of sample 4)
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 complex knitted fabrics. Possibilities of obtaining complex knitted fabrics on modern flat knitting 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.

Results and discussions

In this research work, the technological possibilities of the flat knitting machine were studied, and knitting variants in a new complex structure were created and developed. Technological parameters and physical and mechanical properties 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.

Table 1 Technological parameters of knitting structures

№	Variants	Yarn contamination	Width of loop, A (mm)	Height of loop, B (mm)	Horizontal density, P_g	Vertical density, P_v	Length of loop, L (mm)	Surface density, M_S, g/m^2	Thickness, M (mm)	Volume density, δ, mg/sm^3
1	1.1	50/50 cotton+ PAN Ne=30/2	1,6	0,97	30	51,1	5,92	590,3	2,0	302,7
2	1.2		1,6	1,58	30	35,5	7,1	562,7	2,2	255,8
3	1.3		1,56	1,2	31	43	6,73	502,2	1,8	279,0
4	1.4		1,62	1,2	30	42,5	5,8	527,4	1,6	329,6
5	2.1	100% PAN 20/2	1,61	1,33	32,5	41,5	5,08	480,5	2,0	240,3
6	2.2		2,45	1,25	22,5	42,5	5,13	517,1	2,3	229,8
7	2.3		1,68	1,075	29	47	4,98	463,5	2,1	220,7
8	2.4		1,58	1,19	30,5	47	5,35	543,8	1,9	286,2
9	3.1	100% Polyester 167dtex	1,52	0,7	32	76	3,82	466,2	1,0	466,2
10	3.2		2,45	1,64	22,5	50,5	4,16	486,2	1,2	405,2
11	3.3		1,3	1,2	41,5	58	4,07	438,5	1,1	398,6
12	3.4		2,02	1,3	47	51,5	5,59	488,5	1,6	305,3

Technological parameters such as loop width A (mm), loop height B (mm), horizontal density Pg, vertical density Pv, surface density M_S, thickness M, volume density δ have been defined experimentally. If the results are analyzed, first technological parameter of knitted fabric, the loop width A (mm) (Fig.10) in the complex knitted fabric variants varied in the range of 2.45-1.3 mm (47%). The height of the loop B (mm) varied in the range of 1.64–0.7 (57%) in complex knitted fabric variants.

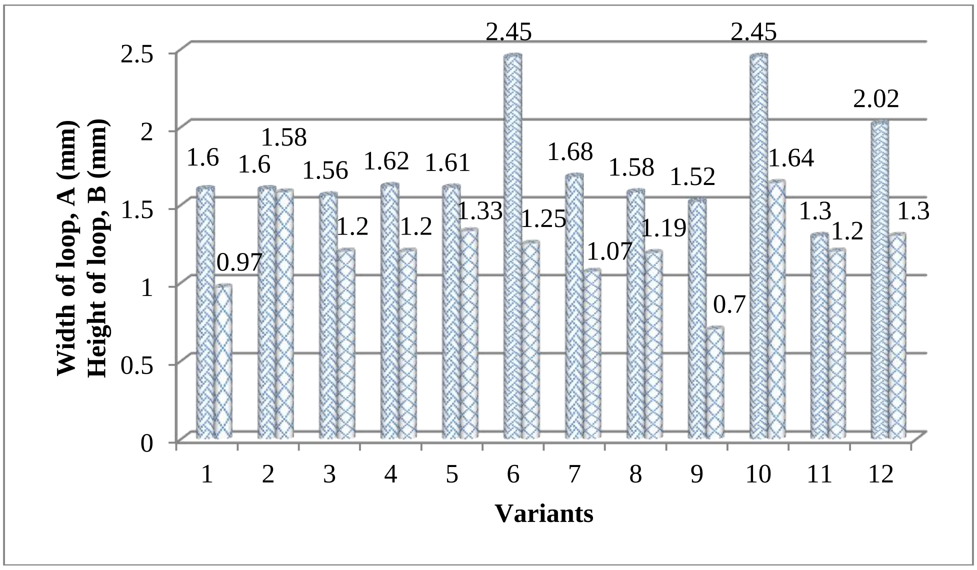

Fig.10. Change diagram of loop width A (mm) and loop height B (mm) on variants.

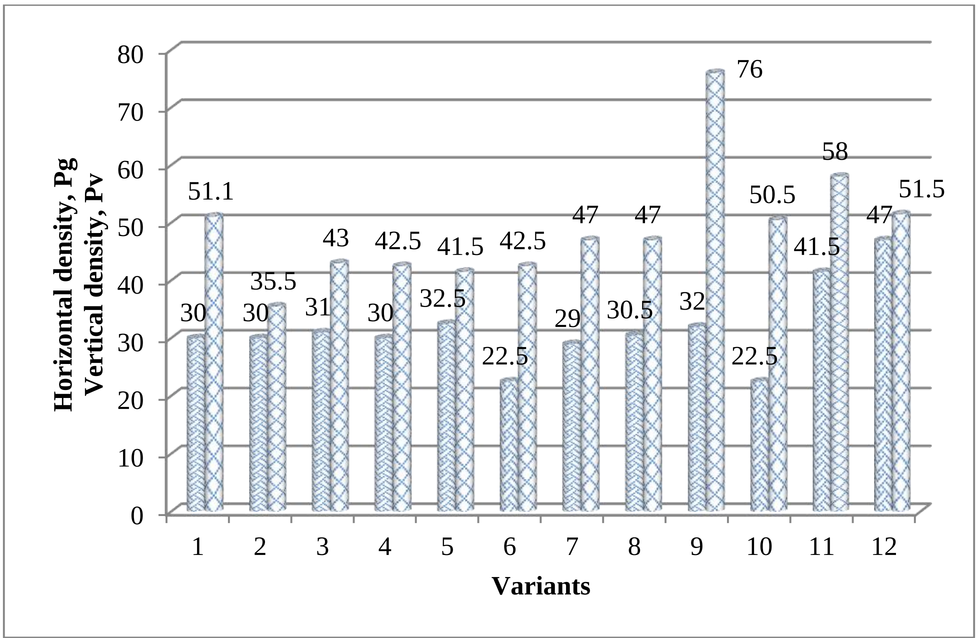

Fig.11. Change diagram of horizontal density Pg and vertical density Pv on variants.

When the results of horizontal density Pg, vertical density Pv are analyzed (fig.11), the horizontal density in the complex knitting fabric variants of the knitted fabric varied in the range of 50.5-22.5 number of loops (55%). Vertical density ranged 35.5-51.5 loop numbers (31%).

According to the results of the analysis of knitted variants, theparameters of the length of the loop in the fabric changed by 3.82-7.1 mm, 46%.

The thickness of the knitted fabric is also taken into account in order to further determine the raw material used. The thickness of the samples can also be determined under laboratory conditions on a special thickness measuring instrument. The thickness of the knitting is 1-2.3 mm according to the variants and it is observed that it varies up to 56%.

Fig.12 shows a graph of the change in length of the loop and thickness of knitting samples as the additional pattern elements in the variants were changed. It is clear that they are subject to a certain law. According to that, the regression equation for the length of the loop and the approximation accuracy are following:

$y = 0,0258x^2 - 0,5387x + 7,4148$ $R^2 = 0,6075$

The regression equation for the thickness and the approximation accuracy are following:

$y = -0,0072x^2 + 0,0187x + 1,9932$ $R^2 = 0,4289$

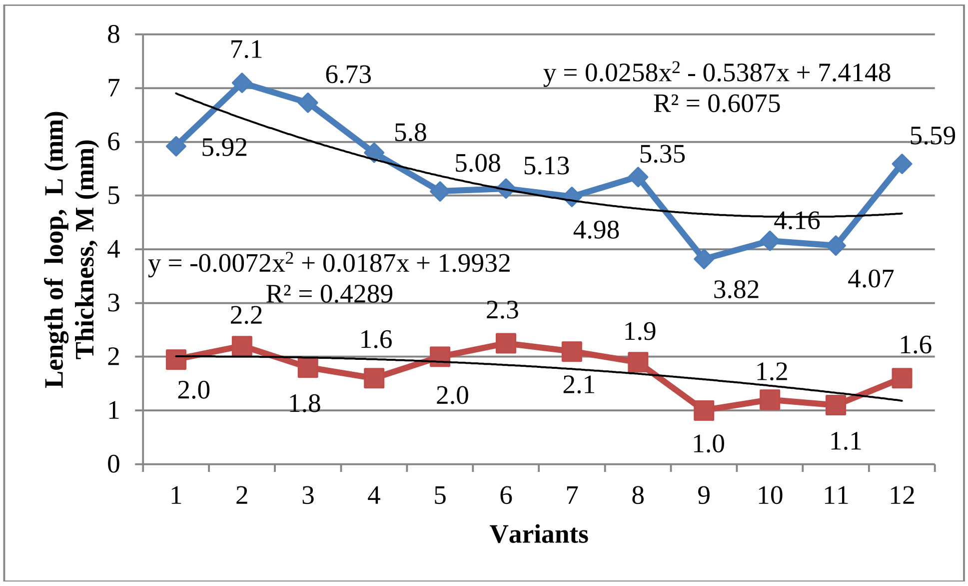

Fig.12. Change graphs of loop length and thickness on variants.

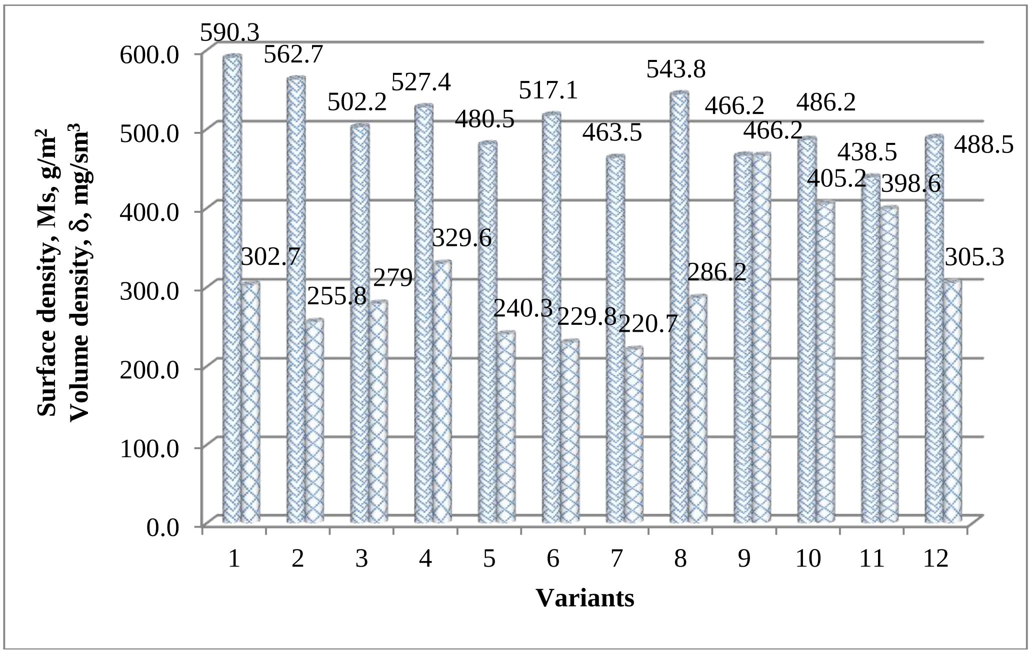

Fig.13. Surface and volume densities change diagram on variants.

Analysis of the surface density of complex knitted fabrics (Fig. 13) shows that the surface density is 590.3–438.5 g / m^2, a change of 25,7% for complex knitted fabrics. Since the surface density is directly related to the raw material consumption and the volume density is related to the knitting thickness, it is correct to estimate by this parameter. The volume density ranged from 220.7 to 466.2, which is 52,6%. A 25,7% change in surface density resulted in a 50% change in volume density.

It should be noted that such knitted fabrics are suitable for assortment of outerwear. Based on the analysis it was found that knitwear has a high shape stability property, and this fabric is recommended for the production of top knitwear. At the same time these variants can be recommended to technical knitting products in accordance to sphere of using because strength properties and decreasing possibility of raw material expenditure.

Conclusion

The types and methods of obtaining complex knitted fabrics were studied. Different variants of effective knitted fabrics with pattern-enhancing have been created and the technology of producing has been developed. Spun cotton, acrylic yarn, and polyester yarns were used to achieve pattern effect and improve pparameters in complex knitted fabrics. It is recommended for the production of top knitwear. At the same time these variants can be recommended to technical knitting products in accordance to sphere of using because strength properties and decreasing possibility of raw material expenditure.

References

1. D. J. Spencer, *Knitting Technology: A Comprehensive Handbook and Practical Guide*, vol. 105, England: Woodhead Publishing Limited, UK, 3rd edition, 2001

2.Hua Wang, Hafeezullah Memon. Cotton Science and Processing Technology. Springer Nature Singapore Pte Ltd. 2020y.

3.K. F. AU Advances in knitting technology. England: Woodhead Publishing Limited, UK 2011.

4.Ye.I. Kornienko, V.A.Zavaruev, O.P. Fomina, S.I.Pivkina, T.O.Kupriyanova. Sposob vyazaniya dvoynogo kulirnogo trikotaja s dopolnitel’nym petel’nym sloem. Izvestiya vysshix uchebnyx zavedeniy № 2 Texnologiya tekstil’noy promyshlennosti 2017g.

5.M.A. Prokazova, Razrabotka assortimenta trikotazha kombinirovannyh perepletenij na baze dvuhsloynogo proizvodnogo lastika, Moskva-2010. Available: https://www.dissercat.com

6. J. E. McIntyre, P. N. Daniels, Textile Terms and Definitions Committee, Textile Institute, Manchester, England (2018).

7.N. R. Khanhadjaeva, M. M. Mukimov “New Knitting Fabric Structure Made on Flat-Bed Knitting Machine” The Second International Symposium on Educational Cooperation for “Industrial Technology Education” Aichi, Japan, 4.07- 6.07.2008

8.Xanxadjaeva N.R., Nabiev A.G., Riskalieva F.M. “Issledovanie texnologicheskix parametrov struktury trikotaja s dvoynym risunchatym pressovym perepleteniem”, SPbGUPTD (Sankt-Peterburgskiy gosudarstvenniy universitet promyshlennyx texnologiy i dizayna) jurnal «Dizayn. Materialy.Texnologiya» Aprel’ 2020, str. 93-97.

9. Xanxadjaeva N.R., Nabiev A.G., Riskalieva F.M. “Research of Loop Transferred Structures on V-Bed Flat Knitting Machine”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-6, March 2020, p. 2565-2570.

10.Xolboev E.B., Xanxadjaeva N.R. Xolxujaeva M.M. Parametry pressovyx perepleteniy s melkorapportnym uzorom. XXIII Mejdunarodnaya nauchno-prakticheskaya telekonferentsiya «Advances in Science and Technology» 15 sentyabrya 2019 g. Moskva, Rossiya

11. Xolboev E.B., Xamidova D.U., Xanxadjaeva N.R. Texnologicheskie vozmojnosti dvuxfonturnogo ploskovyazal’nogo avtomata LONGXING. RGU im. A.N.KOSYGINA (TEXNOLOGII. DIZAYN. ISKUSSTVO) Problemy tekstil’noy otrasli i puti ix resheniya. Vserossiyskiy krugliy stol s mejdunarodnym uchastiem. Sbornik nauchnyx trudov, MOSKVA 2021g.