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Mathematical Modeling Of The Quality Indicators Of Two-Layer Knitted Fabrics Obtained On Flat Two-Needle Knitting Machines With The Needles Placed In A Rubber Arrangement

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Abstract. In the article presents the results of mathematical modeling of the quality indicators of double-layer knitted fabrics on double-bed flat knitting machines and the law of the influence of the structure of knitted fabric on the consumption of weed is determined

Key words: double-layer, knitting, quality, mathematical modeling, raw materials.

The main goal of the analysis of technological processes is to identify laws that are of great importance in practice. Usually, these patterns are caused by many factors, the assessment of their influence is the most important. [1-4]

Factors encountered in practice often have random characteristics, and to evaluate them, it is necessary to use special branches of mathematics - the theory of extimolars and mathematical statistics.

Special attention is paid to experimental studies (later experiments) in research works [5, 6].

Processing is carried out, regression equations are obtained and analyzed on the basis of appropriate graphs, a mathematical model of the process is created.

Mathematical modeling is divided into theoretical and empirical types depending on the chosen method. Observation and analysis of experimental results often play an important role in theoretical research.

Scientific research works are carried out in 3 different ways: theoretical, experimental, theoretical-experimental [7].

Technological processes of textile, cotton and light industry are complex processes that depend on the changes of many interrelated factors. Therefore, scientific research of these processes is carried out on the basis of mathematical models.

In the course of ongoing research, it is necessary to develop mathematical models in the study of the method of obtaining two-layer knitted fabrics of a new structure and the effect of changes in the fabric structure on the technological indicators and physical mechanical properties of knitting. For this, in the experiment, the processes affecting the volume density and elongation factors at break of two-layer knitted fabric samples with a new structure were considered. The indicators of ring pitch-(x_1), ring row height-(x_2) and ring string length-(x_3) were taken as factors influencing the process..

As output factors (y_1) - volume density indicator of knitted fabric was chosen. When selecting the output factors, based on the features of two-layer knitted fabrics, the type of their intended use, as well as the factors that can interact with the quality indicators and are considered important, were selected. Below are the calculations performed for the effect of the placement of the needles in the elastic order and the change of the density of the fabric on the volume density of the fabric (y_1) in the production of two-layer knitted fabrics. In it, the name of the input factors, designation, actual values and change intervals, experimental conditions are given in Table 1.

Table 1

A prerequisite for planning an experiment

№	Name, sign of the factor	Coding symbol	Actual values of the factor			Change interval
			-1	0	+1	
1	Ring step A_{ring}, мм.	x_1	1,55/1,56	1,77/1,78	1,2/2	0,22

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2	Ring row height B_{ring}, мм.	x_2	0,99/1	1,23/1,24	1,47/1,48	0,24
3	Loop thread length L_{ring}, мм.	x_3	4,5/4,6	7,05/7,15	9,6/9,7	2,55

Note 1.: the actual values of the factor are presented in the form of a figure and a denominator, based on the results of parallel experiments 1 and 2.

Based on the results of the obtained experiment, the effect of the change of the input factors of the two-layer knitted fabric on the volume density indicator was studied based on the experimental results.

The experimental results of the output factor in each condition were obtained and their average values are presented in Table 2.

Table 2

Planning matrix, experimental and average values of calculation results

y	Factors			Outgoing factors $У_u$			$\bar{y}$
	x_1	x_2	x_3	y_1	y_2	y_3	
1	-	-	-	185,7	185,8	185,6	185,7
2	+	-	-	201,5	201,4	201,3	201,4
3	-	+	-	205,4	205,6	205,8	205,6
4	+	+	-	218,4	218,5	218,3	218,4
5	-	-	+	224,1	224,3	224,4	224,3
6	+	-	+	231,3	231,4	231,2	231,3
7	-	+	+	235,7	235,6	235,8	235,7
8	+	+	+	238,8	239	238,7	238,8

These outgoing factors (y_1,y_2,y_3) are determined based on the results of the experiment.

Threshold values were determined using Smirnov-Grabs criterion. Here, values of V_{Rmax} and V_{Rmin} calculated for each option are taken from the table. V_T [P_d; m] (P_d-reliability probability) was compared with the value.

For example, with a probability of R_d=0.95, m (repetition of the experiment)=3, Vt =1.412.

If V_{Rmax}>V_T or V_{Rmin}>V_T, then y_{max} or y_{min} values were excluded from further statistical processing.

In this case, the conditions $V_{Rmax}< V_T$ and $V_{Rmin}< V_T$ must be fulfilled.

$V_{Rmax}<V_T$ $\quad$ $V_{Rmin}< V_T$

1,224<1,412 $\quad$ 1,224<1,412

Using the Smirnov-Grabs criterion, the threshold values were determined and the condition was fulfilled.

Testing homogeneity of variances using the Cochrane criterion. Testing for homogeneity of variances was calculated using the Cochrane criterion formula as follows:

$$\sum S_u^2\{y\} - \text{sum of variance} - 0{,}272 \qquad G_R = \frac{S^2_{\max}(y)}{\sum_{i=1}^{N} S_u^2(y)} \cdot \sqrt{\frac{\text{m}}{\text{m-1}}} = 0{,}293 \qquad (1)$$

If G_R<G_T, $\{S^2_y\}$ variances are said to be homogeneous and the analysis of experimental results can be continued. If the variances are not homogeneous, then it is necessary to increase the number of experiments.

The tabular value of the Cochrane criterion is as follows:

$G_T\{P\partial=0,95; f\{S^2_y\}=3\text{-}1; 8\}=0,516$ is equal to.

So, since G_R<G_T i.e. 0.293<0.516, variances are homogeneous.

The hypothesis of homogeneity of variance is not rejected, and the averaged magnitude of S^2_y can then be used to assess the adequacy of the model.

The regression coefficients are found using the method of least squares, the significance of the regression coefficients is determined using the Student's criterion, and the final regression equation is created. As a result, the following model is generated:

$$Y_R = 217{,}65 + 4{,}82x_1 + 6{,}97x_2 + 14{,}87x_3 - 0{,}85x_1x_2 - 2{,}3x_1x_3 - 2{,}25x_2x_3;$$

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The adequacy of the obtained model was checked using Fisher's criterion in calculations.

If $F_R<F_t$, then the model is adequate with the probability R_d.

For this, the experimental and calculated values of the output factor are compared.

Table 3

Чиқувчи факторнинг тажрибавий ва ҳисобий қийматлари

u	$\bar{y}_u$	$\bar{y}_{Ru}$	$\bar{y}_u - y_{Ru}$	$\left(\bar{y}_u - y_{Ru}\right)^2$
1	185,70	185,575	-0,125	0,016
2	201,40	201,525	0,125	0,016
3	205,60	205,725	0,125	0,016
4	218,40	218,275	-0,125	0,016
5	224,30	224,425	0,125	0,016
6	231,30	231,175	-0,125	0,016
7	235,70	235,575	-0,125	0,016
8	238,80	238,925	0,125	0,016
$\sum_{u=1}^{N}$	-	-	0,2	0,125

The adequacy of the model obtained using Fisher's criterion was calculated using the following formula: Here, S^2_y =0,03125; $S^2_{над}$ =0,0340742

$$F_R = \frac{S^2_{\text{НАД}}(y)}{S^2(\bar{y})} = \frac{0{,}0340742}{0{,}03125} = 1{,}0903$$

The tabular value of Fisher's criterion was obtained from a special table.

$F_T\left[P_D = 0{,}95;\ f_2\left(S^2_y\right) = 4,\ \ f_1\left(S^2_{\text{над}}\right) = 16\right] = 3{,}01 \qquad F_R = 1{,}0903\ ;\ F_т = 3{,}01$

Therefore, the model is adequate since $F_R<F_T$.

The production of two-layer knitted fabrics with a new structure and the change of the fabric structure, the change of its volume density index, are suitable. Thus, it is recommended to use linear regression. Changes in the values of the volume density indicators, determination of interrelationships of outgoing and incoming factors, calculations, etc., were expressed with the help of special computer programs, through graphs and curves. It is known that the software is a package of programs that allows you to perform various calculations related to mathematics, technology and economics. The programs are user-friendly for working with formulas, numbers, graphs and texts, and are provided with hundreds of operators and logical functions designed for the numerical and analytical solution of scientific and technical problems of varying complexity. [8-10].

Below, two-layer knitted fabric with a new structure was obtained and the laws of influence of the change of the fabric structure on the quality parameters of the knitted fabric were studied based on the surface deviation isolines for the bulk density factor.

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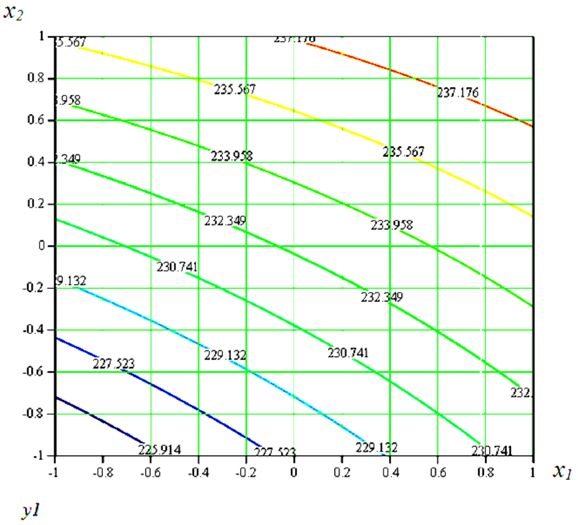
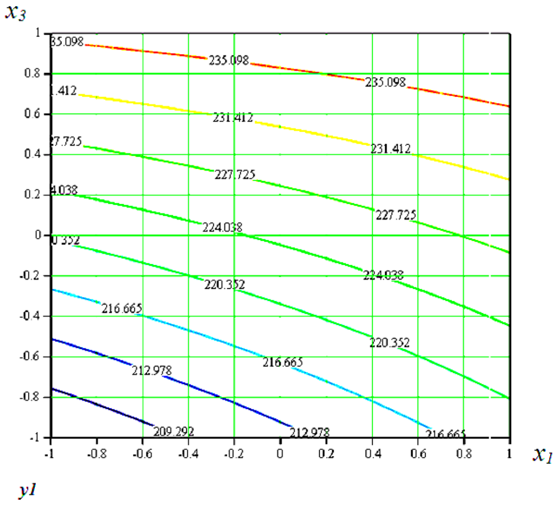
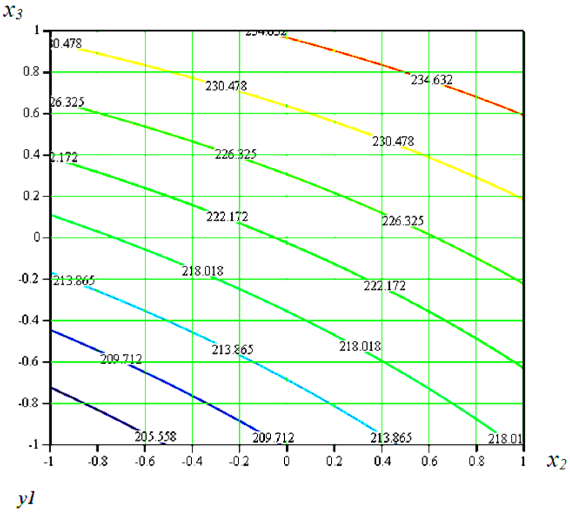


x3=0



x2=0



x1=0

Figure 1. The isoline of the deviation of the volume density indicator values from the surface

Based on the analysis of isolines of deviation from the surface according to the results of the conducted mathematical-statistical processing, the input factors: (x1)-ring pitch A (mm) -1.0÷1.0, (x2)-ring height B (mm) -0.81÷1.0, (x3)-ring thread length L (mm) in the range of 0.58÷1.0, the outgoing factor (y1)-volume density to the lowest values, and (x1)-ring step A (mm) in the range -1.0÷-0.42, (x2)-ring row height B (mm) in the range -1÷1.0, (x3)-ring thread length L (mm) -1.0÷-0.76, it was found that the outgoing factor has the highest values of (y1)-volume density.

As a result of the mathematical-statistical processing of two-layer knitted fabrics of the new structure, it can be concluded that the rational values of the output factor (y1) can be determined based on the analysis of isolines of deviation from the surface at different values of the input factors x1, x2 and x3..

In the rationalization of research results, based on the interdependence of the input factors, the most rational value of the output factor is the ring pitch -(x1) 1.56 mm, the height of the ring row -(x2) 1.1 mm, and the length of the ring thread (x3) 6.85 mm, 207.2 gr/m2 rational value of outgoing factor-(y1) was reached.

Based on the interdependence of the above mentioned factors, the technological performance of the two-layer knitted fabrics of the new structure was improved, that is, the volume density indicator decreased, physical and mechanical properties: breaking strength, air permeability, shape retention properties increased, and the elongation at break indicator decreased.

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Literature

1. Боровков, А.А. Математическая статистика: Учебник / А.А. Боровков. - СПб.: Лань, 2010. - 704 с.
2. Пономарев, В.Б. Математическое моделирование технологических процессов. Екатеринбург: ГОУ ВПО УГТУУПИ, 2006.— 129 с.
3. 3.Советов, Б. Я. Моделирование систем : учеб. для.— Москва : Высш. шк., 2001.— 343 с.
4. 4.Короткий, А. И. Математическое моделирование. Екатеринбург : Изд-во УГТУ-УПИ, 2005.— 102 с
5. Н. П. Бусленко и др. Метод статистических испытаний. Москва: ГИФМЛ, 1962.— 244 с.
6. Севостьянов А. Г. Методы и средства исследования механико-технологических процессов текстильной промышленности. М., 2007. -С. 20-23.
7. Маматов А. З. "Технологик жараёнларни математик моделлаштириш". Услубий қўлланма. Т. 2012. 33-42 б.
8. Губарь, Ю.В. Введение в математическое программирование. Москва : Интернет-Университет информационных технологий, 2007.— 199 с
9. Кирьянов Д. В. К43. Mathcad 15/Mathcad Prime 1.0. -СПб.: БХВ-Петербург, 2012. ISBN 978-5-9775-0746-2. –С. 11-13.
10. http: // www. mathcad. Com