BASED ON THE OPTIMUM PARAMETERS OF THE MACHINE TRANSFERRING COTTON TO OPEN AND CLOSED WAREHOUSES

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Abstract: The article presents the analysis of the optimal parameters of the working parts of the machine used in the transfer of raw cotton to the ginning fields using standard methods. In this case, the influence of the input parameters of each working part on the output factors has been fully studied, and the selected values of the input factors have been determined. Based on the optimal values, a pilot copy of the proposed machine will be built.

Key words: cotton, fiber, waste, model, active, passive, storage area, seed, storage, dirt, moisture, density, weight, quality indicator.

Enter

Today, the importance of research and development in the development of the national economy is increasing, and production enterprises are improving on the basis of world scientific achievements. This improvement is carried out through its automation and mechanization, the use of new techniques and technology.

Every production, including the reception of raw materials in textiles, the production of semi-finished products in various workshops and their reception in the next departments, the production of finished products, the adoption of new techniques, the improvement of technological processes, technological there are common problems such as placement of equipment and optimization of their main technological and structural parameters.

At all these stages, research work is carried out, and at all stages, quality control of semi-finished products, yarn, fabric and finished products is carried out. The most advanced method of processing experimental results is the method of mathematical statistics. The use of statistical methods in conducting experiments and processing their results allows to minimize the size of tests and the amount of processed operations. [1].

STATEMENT OF THE PROBLEM

The experiment is called multi-factorial or factorial planning, and planning in which the levels of all influencing factors are changed at the same time.

This planning method allows to obtain high accuracy results with a small number of experiments. Each regression coefficient in the mathematical model obtained as a result of experiments conducted on the basis of factorial planning is found as a result of all N experiments, so its variance is smaller than the error variance of N experiments.

If the regression mathematical model of the process is in the form of the following linear equation, then it can be used to find the regression coefficients N*n+1 it is enough to conduct experiments and the variance of the regression coefficients decreases as the number of factors increases [2; 26-34 b.]. It was shown that the accuracy of the regression coefficients in the traditional planning method does not depend on the number of factors.

Experiments are carried out in a factorial planning method, they are carried out in a randomized order, that is, in a random sequence. The main purpose of this is to eliminate the influence of uncontrollable factors (raw materials of different quality, time change) on the output parameters, that is, to make their influence random [3; 102-116 b.].

The method of factorial planning of experiments is used in the implementation of full factorial experiment (TOT), residual factor experiment (COT) and central non-composite experiment (MNCT) used to obtain second-order models, Rototabelli central composite experiment (RMCT), etc. [4; 58-72 b.].

The mathematical model obtained on the basis of factor planning of the experiment allows to evaluate not only the influence of each factor on the technological process, but also the interaction.

We plan to use the TOT 23 method for the process we are studying. Because connections between incoming and outgoing factors and outgoing results are intended to be analyzed quickly and with little experience [6; 1-67 b.].

Optimization is carried out with the help of multifactor planning of the experiment, that is, the TOT 23 experiment is conducted. Here, 2 is the number of levels; 3 – number of factors; the number of tests will be 23=8.

1. Factors affecting the implementation of the optimization process and output parameters are selected.

Input parameters that require optimization by value:

X1- Magnetic drum magnet working thickness, (mm).

X2-Distance between piles (mm).

X3- Height h of the pile (on side a, mm).

As an outgoing parameter:

Y1 – Cleaning efficiency of the device (%),

Y2 – The amount of defects and impurities in the fiber (%)

indicators were obtained.

2. Variation limits of the factors are determined and included in the following table.

Table of factor levels in natural value

Table 1.1

Varying factors	Basic level of factors	Bottom level	High level	Range of variation
Magnetic drum magnet working thickness (mm)	10	7	13	3
Distance between piles (mm)	23	20	26	3
Height h of pile (on side a, mm)	30	20	40	10

2. In order to simplify the processing of research results, we will switch from natural values of factors to coded values.

$$x_i = \frac{X_i - X_{ai}}{I_i} \qquad (1.1)$$

Here X_i - coded value of the factor;

X_{ai} - natural value of the second factor;

I_i - range of variation.

The results of coding are included in table 3.2.

Thus, after encoding, all higher levels are denoted by +1 or simply (+) and lower levels by –1 or simply (–).

Factor coding results

1.2 - table

№	Factors that vary	Low level coding	High level coding
1	Magnetic drum magnet working thickness (mm)	$x_1 = \frac{7-10}{3} = -1$	$x_1 = \frac{13-10}{3} = 1$
2	Distance between piles (mm)	$x_2 = \frac{20-23}{3} = -1$	$x_2 = \frac{26-23}{3} = 1$
3	Height h of pile (on side a, mm)	$x_3 = \frac{20-30}{10} = -1$	$x_3 = \frac{40-30}{10} = 1$

Experiments are carried out strictly according to the sequence given in column 4, with the values of the input parameters set. The results are recorded in column 5. The 4-column order is based on a random table, and its task is to eliminate the influence of random factors on the studied process by conducting tests in this order.

№	Factors				Cotton Cleaning Efficiency %				Amount of defects and impurity in the fiber %			
	X_0	X_1	X_2	X_3	Y_{11}	Y_{12}	Y_{13}	$Y_{o'r}$	Y_{21}	Y_{22}	Y_{23}	$Y_{o'r}$
1.	+	-	-	-	3,7	3,9	4,1	3,87	1,9	1,8	1,7	1,8
2.	+	+	-	-	5,7	5,7	6,2	5,86	1,8	1,9	1,8	1,83
3.	+	-	+	-	4,2	4,3	3,8	4,09	2	1,8	2,1	1,96
4.	+	+	+	-	3,7	4,1	3,7	3,85	2,2	2,1	2,3	2,2
5.	+	-	-	+	4,5	4,1	4,8	4,47	2,4	2,5	2,4	2,43
6.	+	+	-	+	4,2	4,6	5,5	4,75	2,2	2,3	2,1	2,2
7.	+	-	+	+	5,1	5,3	5,5	5,33	2,6	2,7	2,8	2,7
8.	+	+	+	+	4,1	3,9	4,0	4	2,4	2,5	2,6	2,5

Table summarizing the results of experiments

1.3 - table (longitudinally)

№	Factors				Interrelated factors				value of	value of	Serial dispersion	Serial dispersion
	x_0	x_1	x_2	x_3	x_1x_2	x_1x_3	x_2x_3	$x_1x_2x_3$			$S^2(Y_1)$	$S^2(Y_2)$
1	+	-	-	-	+	+	+	-	1,8	3,87	0,010	0,039
2	+	+	-	-	-	-	+	+	1,83	5,86	0,003	0,064
3	+	-	+	-	-	+	-	+	1,96	4,09	0,023	0,075
4	+	+	+	-	+	-	-	-	2,2	3,85	0,009	0,061
5	+	-	-	+	+	-	-	+	2,43	4,47	0,003	0,116
6	+	+	-	+	-	+	-	-	2,2	4,75	0,009	0,418
7	+	-	+	+	-	-	+	-	2,7	5,33	0,009	0,043
8	+	+	+	+	+	+	+	+	2,5	4	0,010	0,004

3. The testing matrix is created and the experimental results are processed. The planning matrix in which the research results are included is presented in the table above.

Arithmetic average value of optimization parameters for each test consisting of repetitions of experimental results.

$$\bar{Y} = \frac{\sum_{i=1}^{N} Y_i}{m} \qquad (1.2)$$

is considered.

$$\bar{Y}_{1i}=\frac{17,6}{8}=2,2, \qquad \bar{Y}_{2i}=\frac{36,2}{8}=4,52,$$

$S^2(Y_1)=0,01$ $\qquad$ $S^2(Y_2)=0,14$

Homogeneity of variance is determined using the Cochrane criterion.

$$G_x=\frac{S^2\{Y\}_{max}}{\sum S^2\{Y\}} \qquad (1.4)$$

Here G_x- Estimated value of the Cochrane criterion

$S^2\{Y\}_{max}$- I – maximum variance of the chi test

$\sum S^2\{Y\}$ - sum of all linear variances

to the height

$$G_x\{Y_1\}=\frac{S^2\{Y_1\}_{max}}{\sum S^2\{Y_1\}}=\frac{0,02}{0,08}=0,302$$

1) $G_x\{Y_2\}=\frac{S^2\{Y_2\}_{max}}{\sum S^2\{Y_2\}}=\frac{0,41}{0,82}=0,509$

To determine the recovery of experience, we compare the calculated value of the Cochrane criterion with the table.

In our case TOT 2^3 and $P_D=0,95$ for

$$G_x\{Y_1\}=0,302<G_{tab}=0,5137$$
$$G_x\{Y_2\}=0,5<G_{tab}=0,5137$$

If $G_x\{Y\}<G_{tab}$ there is, it is possible to calculate the regression coefficients.

$$Y_R=b_0+b_1x_1+b_2x_2+b_3x_3+b_{12}x_1x_2+b_{13}x_1x_3+b_{23}x_2x_3+b_{123}x_1x_2x_3 \qquad (1.5)$$

The coefficients in Eq.

$$b_0=\frac{1}{N}\sum Y \qquad (1.6)$$

Here i is the test order

j – order of factors

$$b_i=\frac{1}{N}\sum x_i\bar{Y} \qquad (1.7)$$

$$b_{ij}=\frac{1}{N}\sum x_ix_j\bar{Y} \qquad (1.8)$$

For our example, it is as follows:

Y1- Calculation of the coefficients in the equation according to the amount of impurities and defects:

$$Y_1=2,2+0,25x_1+0,13x_2-0,02x_3+0,005x_1x_2-0,08x_1x_3+0,3x_2x_3-0,02x_1x_2x_3$$

Y2- Calculation of the coefficients in the equation according to the cleaning efficiency:

$$Y_2=4,52+0,11x_1-0,21x_2+0,08x_3+0,23x_1x_2-0,35x_1x_3-0,48x_2x_3+0,07x_1x_2x_3$$

The significance of the regression coefficients is determined using the Student's criterion tR:

$$t_R\{b_i\}=\frac{|b_i|}{S\{b_i\}} \tag{1.9}$$

$$S\{b_i\}=\frac{S^2\{Y\}}{N} \tag{1.10}$$

Here S2{Y} – linear variance. It is determined using the following formula.

$$S^2\{Y\}=\frac{1}{m}S^2\{\overline{Y}\} \tag{1.11}$$

Here, m is the number of test repetitions.

$S^2\{\overline{Y}\}$ - recovery variance. It is determined using the following formula.

$$S_m^2\{Y\}=\frac{1}{N}S^2\{Y\} \tag{1.12}$$

Here N is the number of trials.

$S^2(Y_1)$ - sum of linear variancesi:

$S^2(b_0)=\frac{1}{8}0,08=0,0095$ $\qquad$ $S^2(b_{ij})=\frac{0,0012}{8}=0,0001$

$S^2(b_i)=\frac{1}{8}0,0095=0,0012$ $\qquad$ $S(b_{ii})=\sqrt{0,0001}=0,01\,2$

$S^2(Y_2)$ - sum of linear variances:

$S^2(b_0)=\frac{1}{8}0,82=0,102$ $\qquad$ $S^2(b_{ij})=\frac{0,012}{8}=0,0016$

$S^2(b_i)=\frac{1}{8}0,102=0,_{0}12$ $\qquad S(b_{ii})=\sqrt{0,0016}=0,04$

We determine the calculated values of the Student's criterion for the calculated coefficients:

Y1- Calculated values of Student's criterion for:

$t_1(b_0)=\frac{|2,202|}{0,009}=231,8$ $\qquad t_1(b_{12})=\frac{|0,005|}{0,0001}=33,7$

$t_1(b_1)=\frac{|0,255|}{0,001}=214,7$ $\qquad t_1(b_{13})=\frac{|-0,087|}{0,0001}=589,5$

$t_1(b_2)=\frac{|0,1375|}{0,0012}=115,8$ $\qquad t_1(b_{23})=\frac{|0,03|}{0,0001}=202,1$

$t_1(b_3)=\frac{|-0,02|}{0,0012}=16,8$ $\qquad t_1(b_{123})=\frac{|-0,022|}{0,012}=1,8$

Y2- Calculated values of Student's criterion for:

$t_2(b_0)=\frac{|4,52|}{0,1025}=44,2$ $\qquad t_2(b_{12})=\frac{|0,2375|}{0,0016}=148,3$

$t_2(b_1)=\frac{|0,11|}{0,12}=8,6$ $\qquad t_2(b_{13})=\frac{|-0,35|}{0,016}=218,5$

$t_2(b_2)=\frac{|-0,21|}{0,012}=16,4$ $\qquad t_2(b_{23})=\frac{|-0,48|}{0,016}=299,7$

$t_2(b_3)=\frac{|0,87|}{0,12}=6,8$ $\qquad t_2(b_{123})=\frac{|0,0775|}{0,04}=1,9$

The calculated value of the student's criterion is compared with the tabular value of this criterion obtained from the 3rd appendix of the textbook "Fundamentals of modeling technological processes of the textile industry".

$f_2=(m-1)N=16;$ here m=3, N=8 $\quad t_{tab}[P=0,95;f_2=16]=2,12$

If the regression coefficients $t_R>t_{tab}$, will be important.

Thus, Y_1 – in our equation for the amount of impurities and defects caused by the use of our device $b_0, b_1, b_2, b_{12}, b_{23}$ coefficients became significant and Y_2 – our equation for the cleaning efficiency of the device b_0, b_1, b_3, b_{12} coefficients became significant [2; 1-114 b.]. The regression equation looks like this after discarding the non-significant coefficients::

Y1- Calculate the coefficients in the equation for the amount of impurities

and impurities in the fiber:

$$Y_1 = 2{,}2 + 0{,}25x_1 + 0{,}13x_2 - 0{,}02x_3 + 0{,}005x_1x_2 - 0{,}08x_1x_3 + 0{,}3x_2x_3$$

Y2- Calculation of coefficients in the equation according to the efficiency of

cleaning:

$$Y_2 = 4{,}52 + 0{,}11x_1 - 0{,}21x_2 + 0{,}08x_3 + 0{,}23x_1x_2 - 0{,}35x_1x_3 - 0{,}48x_2x_3$$

It should not be forgotten that if all regression coefficients are significant, the model is considered inadequate. The model can be tested even if only one coefficient is not significant.

The resulting equation is checked for adequacy. The test is performed using Fisher's test. The estimated value of Fisher's criterion is determined as follows.

$$F_R = \frac{S_{ad}^2\{Y\}}{S^2\{Y\}} \qquad N - M > 0 \qquad (1.14)$$

Here $S_{ad}^2\{Y\}$- adequate variance

$S^2\{Y\}$- linear variance (3.3 – determined by the formula)

$S^2(Y_1) = 0{,}01$ $\qquad$ $S^2(Y_2) = 0{,}14$

$$S_{ad}^2\{Y\} = \frac{m}{\text{N-M}} \sum (Y_i - Y_{Ri}) \qquad (1.15)$$

Here M is the number of significant regression coefficients (M=7,1,7,1), N is the total number of tests (N=8), m is the number of repeated tests (m=3).

The calculated value of the optimized factor Y (1.13) (1.14) equation 1.3 is determined by putting the coded values of (–1 and +1) from columns 2 and 3 of the table. Values are taken row-wise, not column-wise. Calculations for formula Y are as follows:

We determine the adequacy variance using the formula (1.15).:

Y1- Calculation of Adequacy Dispersion by the amount of defects and impurity in the fiber:

$$S_{ad}^{2}\{Y_1\}=\frac{3}{8\text{-}7}0{,}004=0{,}12$$

$$F_{RY1}=\frac{0{,}12}{0{,}08}=0{,}15$$

Y_2- Calculation of Adequacy dispersion according to the amount of mechanical damage of the pipe:

$$S_{ad}^{2}\{Y_2\}=\frac{3}{8\text{-}7}0{,}048=0{,}144$$

$$F_{RY2}=\frac{0{,}144}{0{,}82}=0{,}17$$

The tabular value of this criterion is taken from Appendix 4 of the textbook "Fundamentals of Modeling Technological Processes of the Textile Industry" and is equal to the following for our example.

$$F_{tab}=[P=0{,}95;f_1=N(m-1)=16;f_2=N-M=7]=2{,}12$$

If $F_m<F_{jtab}$, the template is adequate. Under investigation $F_{m1}<F_{tab}(0{,}12<0{,}15,0{,}14<0{,}17)$, so the process is stationary and the model is adequate.

Since the equation is adequate, the mathematical model is analyzed.

The analysis can be carried out only according to the coded pattern of factor values. The value of the regression coefficients describes the contribution of the corresponding factor to the amount of the output parameter.

CONCLUSION

As a result of this research, a mathematical model of the machine for transferring cotton to open and closed warehouses was developed, and it was possible to prevent cotton from being stored with active impurities in the gins, and after using a blind conveyor during the transfer process, additional fractions in the raw material were reduced, and cotton was partially cleaned before ginning. , the decrease in the cost of the product was eliminated due to the reduction of dirt, as well as the reduction of energy consumption required for cleaning was achieved and quality preservation of low-grade cotton was ensured. It is explained by the fact that in order to eliminate these shortcomings, a belt conveyor of a new design was proposed and put into production. The results of the research serve to develop the theoretical basis of cotton preliminary processing, including the transfer of cotton raw materials to open and closed types of fields. Its practical importance is based on the fact that the created technical solutions are developed and put into practice based on the need for production, as well as the high economic efficiency that can be obtained.

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