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STUDY OF THE DEPENDENCE OF THE AMOUNT AND COMPOSITION OF FIBROUS WASTE ON THE CONSTRUCTION OF THE WORKING PARTS OF THE CLEANING MACHINE

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Abstract
Cleaning cotton fibre in this article performance parameters of the machines were studied. Factors affecting the implementation of the approval process and emerging parameters were selected. A standard matrix recommended for a three-factor experiment was used. The test matrix was created and the experimental results were processed. Testsoptimal conditions of the amount of fibres suitable for spinning in the fibre waste according to the analysis studies have been carried out.

Keywords: cleaning, perforated surface, hole diameter on the surface, drum speed, distance between drum and surface, matrix, full factor experiment.

Introduction

The problem of reducing the amount of waste generated in production enterprises is one of the important issues, and the process of its implementation is limited in terms of possibilities. Because the generation of waste is an objective necessity and technological inevitability, and it is related to the nature of the process. This need arises during the pre-processing of seed cotton, cleaning of fibre raw materials, binding of semi-finished products, forming a package, cutting the fabric to a specified size for making a product, and similar requirements [1].

If you take a sample of a certain amount of cotton fibre and analyze its composition, you can see that there are different characteristics and defective fibres in addition to normal mature fibres [2, 3]. Such defects are biological and mechanical, and they appear during the growth and development of cotton, during the initial processing of seed cotton in cotton gins, and the extraction of yarn from cotton fibres in spinning mills. The more defects there are, the quality of the cotton fibre decreases, the technological processes of its processing become more complicated, the amount of waste increases, and the amount of yarn output decreases. As a result, the quality of spun yarn decreases, its cost increases, and the number of yarn breakages during the spinning process increases. This, in turn, leads to a decrease in the productivity of spinning machines [1, 4].

The Main Part

Based on experiments, it was found that fibres with the property of spinning are included in the waste separation as a result of the process of cleaning and combing fibre products [5].

Standards for raw material consumption and waste output in the production of cotton fibre products have been developed by scientific inspection institutes. The following methods were used for this [6].

- Calculation method - in which technological and (filling) practical factors are carried out by mathematical correlation and analysis of formation elements. In this method, it is assumed that the achievements of the efficient use of production resources of advanced enterprises and the processes of technological processing of raw materials will be reflected. It is not possible to establish calculation standards for all types of waste, because the relationship between the properties of raw materials and the amount of waste has not been sufficiently studied.
- Experimental method - this method is used to determine the norm of technological waste output. In this case, the amount of waste is determined based on experience by processing raw materials in a certain batch in the cleaning, combing and re-combing departments.
- Observe method - this method is used to determine individual values. In this way, it is necessary to create normal conditions for technological processes and to adjust machines and equipment to the required level, and it should be carried out in advanced enterprises. It is also necessary to establish a rational use of raw materials in these advanced enterprises. The number of observations should be at least 20 times and in some cases up to 50 times. A variation of up to 10% in the number of observations is allowed, taking into account local conditions.
- Statistical method - based on the technical assessment of the calculation of norms by an expert.

In the waste-receiving department of the spinning mills, each waste quality is determined and separated into groups. The technical control department develops recommendations on waste storage procedures and their use. The waste brought to the waste reception department is separated according to standards, and the useful fibres in their content are determined by a laboratory employee using an analyzer [7].

In our scientific research work, a new perforated surface was used instead of a separating knife to prevent the inclusion of spinnable fibres in the waste. It is known that during the cleaning process with a drum covered with a saw-tooth coating, the possibility of separating the incoming fibre product into small bundles and separate fibres increases. As a result, the fibre product is better cleaned of various impurities and foreign bodies. Because the forces of friction and interaction between the fibres in the product are sharply reduced.

Based on the purpose of the research, the performance parameters of the cleaning machines were studied.

Factors affecting the implementation of the approval process and emerging parameters were selected (Table 1). The following were taken as input parameters, the value of which is required to be optimized:

x_1 - diameter of the hole on the surface, mm;

x_2 - drum speed, m/min;

x_3 - the distance between the drum and the surface, mm.

The percentage of long fibres in fibrous waste (%) was selected as the output parameter. Him Y was determined by

Table 1. Table of factor levels in natural value

Variable factors	Basic level of factors	Bottom level	High level	Range of variation
The diameter of the hole on the surface. (mm)	9	6	12	3
Cleaning drum speed. (m/min)	180	160	200	20
Distance between drum and surface. (mm)	6	5	7	1

A standard matrix recommended for a three-factor experiment was used. The test matrix was created and the experimental results were processed. The planning matrix, including the results of the research, is presented in the following table (table 2).

Table 2. Table summarizing the results of experiments

No	Factors				Interrelated factors				Y value of	Serial variance
	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	+	-	-	-	+	+	+	-	7.6	1.2
2	+	+	-	-	-	-	+	+	8.1	1.5
3	+	-	+	-	-	+	-	+	9.0	1.6
4	+	+	+	-	+	-	-	-	11.6	2.1
5	+	-	-	+	+	-	-	+	10.4	1.7
6	+	+	-	+	-	+	-	-	11.4	1.2
7	+	-	+	+	-	-	+	-	10.2	1.8
8	+	+	+	+	+	+	+	+	11.6	2.1

The value of linear variances according to the experiment is calculated by the following formula.

$$S^2\{Y\} = \frac{\sum (Y_i - Y_1)^2}{m-1} \quad (1)$$

The homogeneity of variance is determined using the Cochrane criterion.

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

in this

G_x - The estimated value of the Cochrane criterion

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

In our case, for TOT 23 and PD=0.95

$$G_{jad}[P_D = 0{,}95;\ f\{S_u^2 = m-1 = 3-1 = 2;\ N = 8] = 0{,}5137$$

Homogeneity of variances was found in all tested experiments. $G_x\{Y\} < G_{jad}$ regression coefficients were calculated.

$$Y_R = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + b_{123}x_1x_2x_3 \quad (3)$$

The coefficients in the equation are calculated as follows.

$$b_0 = \frac{1}{N}\sum Y \quad (4)$$

$$b_i = \frac{1}{N}\sum x_i \bar{Y} \quad (5)$$

$$b_{ij} = \frac{1}{N}\sum x_i x_j \bar{Y} \quad (6)$$

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

$$t_R\{b_i\} = \frac{|b_i|}{S\{b_i\}} \quad (7)$$

The calculated value of the Student's criterion [8] is compared with the tabular value of this criterion taken from Appendix 3 of the literature.

$f_2 = (m-1)N = 16$; where m=3, N=8 $t_{jad}[P_D = 0{,}95; f_2 = 16] = 2{,}12$

And so Y - in our equation for the percentage of long fibres in fibrous waste $b_0, b_1, b_2, b_3, b_{23}$ coefficients became significant. The regression equation, after discarding the non-significant coefficients, looked like this:

$$Y = 9{,}99 + 0{,}69x_1 + 0{,}61x_2 + 0{,}91x_3 - 0{,}61x_2x_3 \quad (8)$$

Adequacy was confirmed when the resulting equation was tested using Fisher's test.

Based on the obtained results, the following drawings were made using a computer program (Figures 1, 2, 3).

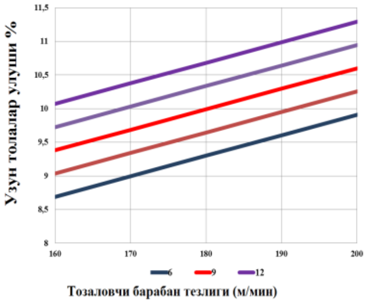

Figure 1. Effect of drum rotation speed on long fibre yield.

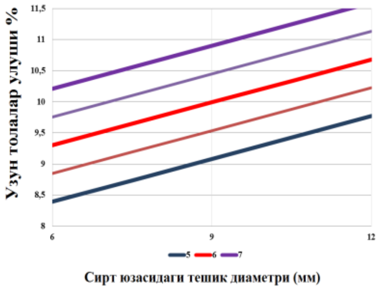

Figure 2. The effect of surface hole diameter on the yield of long fibres

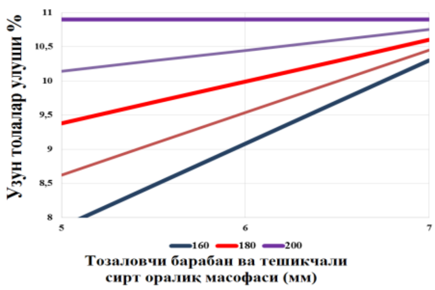

Figure 3. Effect of drum-perforated surface spacing on long fibre yield

From the analysis of the graphs above, it was found that the optimal conditions for the number of fibres suitable for spinning in the composition of fibrous waste were reached at the following values:

The diameter of the hole on the surface is 9 mm;

The speed of the cleaning drum is 180 m/min;

The distance between the drum and the surface is 6 mm.

From the analysis of the graphs, it was found that when the diameter of the hole on the surface is 6 mm, the percentage of long fibres in the fibre waste is small, but it is observed that the amount of knots and fibre waste in the fibre layer is more likely to exceed.

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