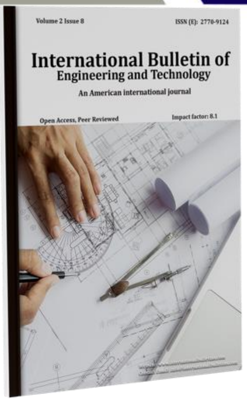

THEORETICAL STUDY OF A DEVICE FOR CLEANING COTTON FROM SMALL IMPURITIES BASED ON A MATHEMATICAL MODEL

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ANNOTATION.

The article proposes a cotton gin with a stacked drum located at an angle for cleaning cotton from small impurities at cotton gin plants. In order to determine the optimal parameters of the research carried out in the new development, the experiments were planned as multifactorial and were carried out on the basis of the established standard, that is, the BOT 24-1 experiment was carried out. The values obtained during the experiment were processed in a modern computer program and regression equations were obtained. The coefficients of the regression equations were tested for significance based on the Student's t test, and the resulting equation was tested for adequacy using the Fisher test.

Keywords: drum, slope, performance, clearance, design, study, oval, surface, performance, impurities, axis, diameter, useful surface.

Introduction

The importance of research work in the development of all sectors of the national economy of Uzbekistan is growing even more, and production enterprises are being improved on the basis of the achievements of world science. This improvement is carried out through its automation and mechanization, the use of new methods and technologies. Research work, depending on the methods of its implementation, is divided into the following types: theoretical, experimental and theoretical-experimental.

Theoretical research is analyzed based on a previously known pattern, in which the relationship between the parameters of a technological process or object is theoretically investigated, while in experimental research this is done by conducting experiments. At present, the introduction of new equipment and modern computing technologies into the production process requires complete and high-quality research work. In theoretical-experimental R&D, both theoretical and experimental results are taken into account, and at present, a more theoretical-experimental type of research is increasingly used. [1,8]

The production of high-quality fiber and seeds while preserving the natural properties of cotton is an important task for cotton ginning enterprises. As a result of scientific research, the interaction of cotton with the technological process during its cleaning, before the process of separating cotton fiber from seeds, it is cleaned on cleaning machines to prevent impurities and other foreign substances from entering it that affect the quality of the fiber.[1]

Cotton gins consist of sections of peg drums and saw drums. As a result of the mechanical action of the pegs and saw drums on the cotton, the impurities contained in it are separated and then transferred to the process. Therefore, at cotton ginning plants, the cleaning department is considered one of the main divisions of the cotton ginning enterprise.

Its equipment and machines work together and continuously in the technological process of the cotton ginning enterprise. In the cleaning compartments, two types of cleaners are installed, separating small impurities (leaves, shavings) and large impurities (stone, clay, metal fragments).

There are several types of cleaning equipment in operation at the cotton ginning plants of our republic. For example, OX B -10, XK, УXK, 6A-12M, ЧX-3M2 and so on. These equipments differ from each other in their working processes. Cotton cleaning from small impurities is carried out on the basis of cotton titration and passing the separated fractions through a mesh barrier. The main working parts of the machines for cleaning from small impurities are pile drums or pile-screw and mesh (grate) surfaces. [2,3,4,5] The recently proposed cotton cleaning installation was made in the form of an oval with a mesh surface in order to increase the usefulness of the mesh surface (which increases the passage of dirty impurities through the surface without clogging), while the drum inclination was $\alpha = 10^{0}$ in order to increase the total cleaning surface, $\cos\alpha < \frac{S}{S_1} \leftrightarrow S_1 \frac{S}{\cos\alpha} \leftrightarrow \cos\alpha < 1 \leftrightarrow S < S_1$ the inequality is performed. It can be seen from this that the surface and path of cotton cleaning increase, if the path of cotton during cleaning increases, then the quality of cotton cleaning also increases. The arrows placed in the drum are installed vertically, which facilitates the titration of cotton inside the drum and accelerates and increases the output of small cotton impurities from the mesh surface. [6,7,9]

Technological processes in the cotton industry consist of a complex of physical and mechanical phenomena that can be successfully studied only using modern achievements of science and technology. Therefore, it is desirable to conduct scientific research based on mathematical modeling.

Research methods

When studying the structure and input parameters of a cotton cleaning device for small impurities that determine the quality of work, it is advisable to effectively use multifactorial mathematical modeling.

The influencing factors are the input indicators x_1 - the rotation speed of the peg drum, rpm, x_2 – drum tilt angle, degrees, x_3 – peg height, mm. The choice of levels and intervals of change of the studied factors is presented in Table 1.

The factors under study are the choice of levels and intervals of change.

Table 1

Multivariate experimental research indicators

Name and designation of indicators		Modification levels			Modification range
		-1	0	+1	
Peg drum rotation speed , rpm	x_1	300	400	500	100
Drum tilt angle, Degrees	x_2	5	10	15	5
Peg height, mm	x_3	70	125	180	55

When determining the regression coefficients, the Student's criterion was used to check whether the mathematical model is adequate or not - the Fisher criterion.

As outgoing factors Y_1 – by cleaning efficiency (%).

The main task set before the mathematical modeling in the study was to obtain the graphs of deviations of isolines based on computational models using programs built in the

Pascal programming language, using the factors affecting it, to determine the cleaning efficiency and the degree of damage to cotton seeds. Using these isolines, we can determine the optimal values of the number of revolutions of the drum, the angles of inclination and the height of the peg based on the factors affecting the cleaning efficiency of the device. From the results of the multifactorial experiment it turned out that the process under study is represented by a higher-order equation. Therefore, to obtain a second-order regression mathematical model, somewhat simpler and more convenient compared to other methods, a central non-compositional experiment (CNE) was chosen and conducted, which is widely used in studies of technological processes in the cotton industry. Based on the results of the experiment, we are looking for a multifactorial mathematical model of second-order regression. As a result of this experiment, the following general regression model can be obtained:

$$Y_R = b_0 + \sum_{i-1}^{M} b_i\, x_i + \sum_{i=j=1}^{n} b_{ij} x_i\, x_j + \sum_{i=1}^{M} b_{ii}\, x_i^2$$

Or, since there are three factors involved in our experiment, the above expression becomes:

$$Y_R = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + b_{11}x_2^2 + b_{33}x_3^2$$

In the equation

b_0 .. b_1 .. - regression coefficients,

x_1, x_2, x_3 - coded value of factors.

- Y_1 - cleaning efficiency:

$$\mathbf{Y_{R_1} = 67,7 + 1,18x_1 - 0,11x_2 - 2,11x_3 + 0,47x_1x_2 + 3,98x_1x_3 + 1,1x_2x_3}$$
$$\mathbf{-0,15x_1^2 - 0,64x_2^2 - 2,14x_3^2}$$

The equation is rewritten with significant coefficients:

$$Y_{R_1} = 67{,}7 + 1{,}18x_1 - 2{,}11x_3 + 3{,}98x_1x_3 - 1{,}1x_2x_3 - 2{,}14x_3^2$$

Results

With the three-dimensionality of the obtained equations and their graphical representation, one of the input factors was taken as the average value ($x_1 = 0$, $x_2 = 0$ or $X_3 = 0$) and was expressed graphically by rewriting the equation in 3-dimensional representations.

We rewrite the regression models on the effective Y_1 into the equation when the peg height is ($X_3 = 0$).

$$Y_R = 67{,}7 + 1{,}18x_1$$

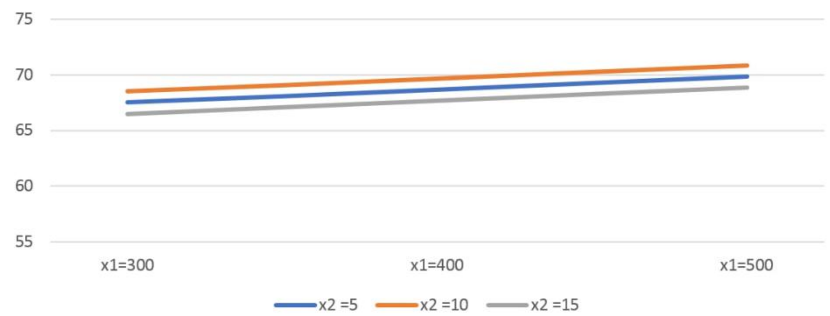

Figure 1. Graph of the rotation speed of the peg drum and the angle of inclination of the drum

As can be seen from the graph, when changing the input first (X_1,) and second (X_2) factors from the accepted minimum (-1) value to the maximum (1) value and the third factor

X_3 =0, using the average value (Y_1), the cleaning efficiency values (by height) are displayed. The drawing shows a graph of the change in cleaning efficiency at the values of X1 - the rotation speed of the peg drum (mm) in the range of 300 ÷ 500 and X_2 - the drum tilt angle (degrees) in the range of 5 ÷ 15 (Y_2). In this case, the highest cleaning efficiency values are achieved at a rotation speed of 500 rpm and a drum tilt angle of 10 degrees (Fig. 1).

$$Y_{R_1} = 67{,}7 - 2{,}11x_3 + 1{,}1x_2x_3 - 2{,}14x_3^2$$

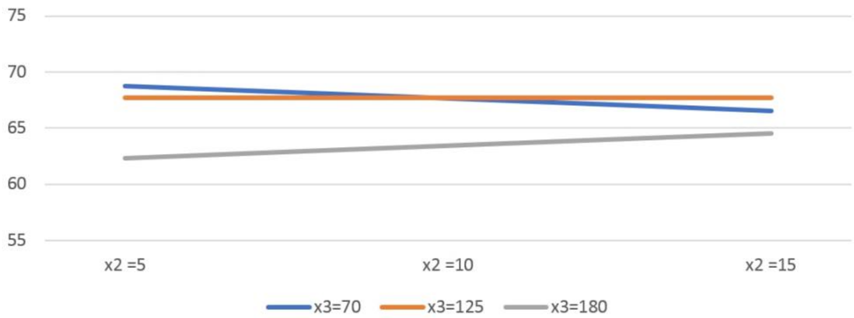

Figure 2. Graph of the dependence of the regression model of cleaning efficiency on the peg height and the drum inclination angle.

It is evident from the graph that when changing the input second (x_2) and third (x_3) factors from the accepted minimum (-1) value to the maximum (1), and the first factor to x_1 =0, using the average value (Y_1), the cleaning efficiency values (by height) are displayed. With the help of the drawing, the highest values of the efficiency of the cotton gin peg are achieved X_2 - the angle of inclination of the drum, (Degrees) at values in the range of 5÷15, X_3 - the height of the peg (mm) at values in the range of 180 and (Y_1) (Fig. 2).

$$Y_{R_1} = 67{,}7 + 1{,}18x_1 - 2{,}11x_3 + 3{,}98x_1x_3 - 2{,}14x_3^2$$

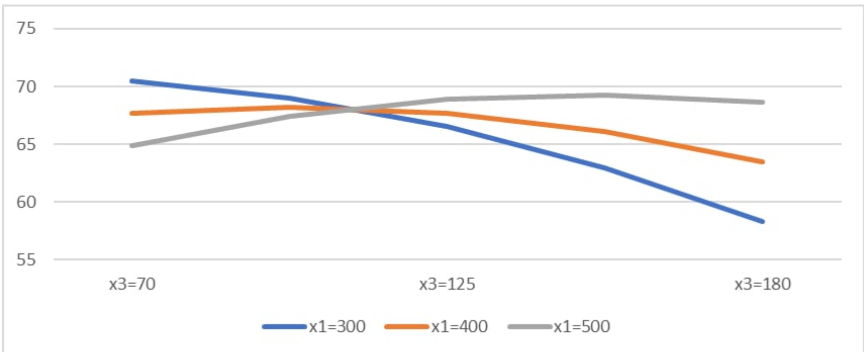

Figure 3. Plot of the dependence of the pile drum rotation speed and pile height on the regression model of cleaning efficiency

The values of the first (X_1) and third (X_3) input factors for the cleaning efficiency (Y_1) are described when changing from the accepted minimum (-1) to the maximum (1) value and using the average value of the second factor x2=0. According to the drawing, the rotation speed of the drum of the peg X_1 of the device for cleaning from small impurities, (rpm), the height of the peg X_3 with values in the range of 400÷500, (mm) 180 and (Y_1) reach the highest values of operating efficiency (Fig. 3).

Conclusions .

The theoretical study of the cotton cleaning device for small impurities based on the proposed mathematical model confirms that the design with an inclined drum and an oval mesh surface allows for an increase in the total cleaning area, which contributes to more efficient separation of impurities. Experiments have shown that the most significant factors affecting the cleaning efficiency include the rotation speed of the peg drum, its tilt angle, and the height of the pegs. The results of mathematical modeling confirm that the optimal operating conditions of the device are achieved at a drum rotation speed of 500 rpm, a drum tilt angle of 10 degrees, and a peg height of 180 mm. With these parameters, the maximum efficiency of cotton cleaning from small impurities is achieved. Thus, the proposed improvement in the design of the device can be successfully implemented at cotton ginning enterprises to improve fiber quality and increase productivity.

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