

The Theoretical Studies of the Cultivation of Three Cotton Seeds along the Plain

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Abstract

As it is known, the main purpose of production of cotton fiber in the technological processes is to produce high quality cotton fiber. Lots of processes in the enterprise have a loss of cotton fiber, which is a valuable raw material for the textile industry.

Keywords

Cotton, Cotton Fiber, Lower Seeds, Surface, Frequency, Thickness, Corner, Separated, Coordinate System, Vibro-Catcher

1. Introduction

The production of cotton products and the cotton industry occupies an important place in the economy of Uzbekistan, as a result of which a number of decrees and higher-level decisions on the cardinal transformation of this sphere of the economy have been adopted lately [1] [2], and the output of cotton for the last 5 years has been declining its consumption within the country is gradually increasing [3]. The country is striving to rebuild its economy with the production of deep processing of cotton, bringing raw cotton to finished products. Therefore, scientific research aimed at improving the quantitative and qualitative indicators of cotton products for the country is of great importance.

Currently mechanical method of catching not-well-ginned seeds and free fiber is being used, and in this process fiber and seeds can get harmed as well.

One of the main advantages of vibro-catchers for not-ginned fractions of cotton seeds and free fiber is the absence of punching effect to material. At our institute and at “Kosonsoy cotton fiber” company, a kinematic awakening device was designed and manufactured to capture unprotected seeds and free fibers.

In our research, theoretical researches on the possibility of forming

one-layered flow of processed seed fertilizers were conducted and conditions for their acceleration were determined.

2. Analysis of the State of Cotton Seeds Being Processed

The most common type of freed slaughtered cotton and the state of products obtained after its destruction is the shift in the center of gravity of the particles resembling (Figure 1(a)).

We examine the static balance of three cotton seeds, which are taken in the form of short cylinders, one of which is associated with the remaining two remaining drain off surfaces. First we will consider the symmetric arrangement of the upper cylinder with the weighted velocity of m and R determined by R . The lower cylinders have a homogeneous radius (R_0) and mass (m_0), equal to $2l$ in the balance position.

Let's define the cylinder balance condition, in which case we call the half-corner angle as φ_0 .

Particularly, in the cotton mass taken after ginning process, there are also fibered seeds, which can get into lint during linting process. In order to solve this problem, devices that allow separating fibered seeds according to geometrical parameters and fertility have been tested [4] [5].

One of them is a net-faced sorting device, proposed by the authors of the article. In this article, theoretical researches on the movement and selection of seeds on the net surface of the device were conducted. Let's assume that the three seed systems move horizontally along a plain surface under a corner (Figure 2). We consider the weight of the upper and lower seeds as m_1 and m_2 , considering seeds as cylinders [6]. Thus, the bottom seeds have the same weight and all three seeds have equal radiuses, and the distance between the upper and lower seeds is l .

From the center of the upper seeds to the plains the initial time is equal to h_0 , and the unification of seeds during motion takes place only between the upper and lower seeds. At point 0, let's set the coordinate head, we set the OX axis along the plain and the OY axis at the perpendicular position. We define the coordinates of seeds as $M_1(X_1 Y_1)$, $M_2(X_2 Y_2)$ and $M_3(X_3 Y_3)$.

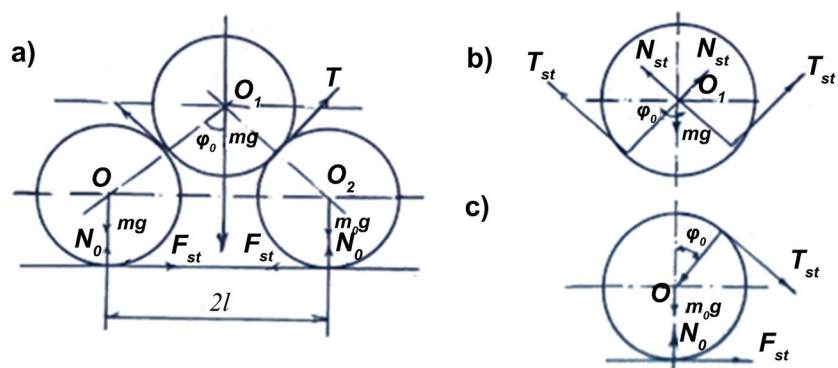


Figure 1. The location of the three seed systems.

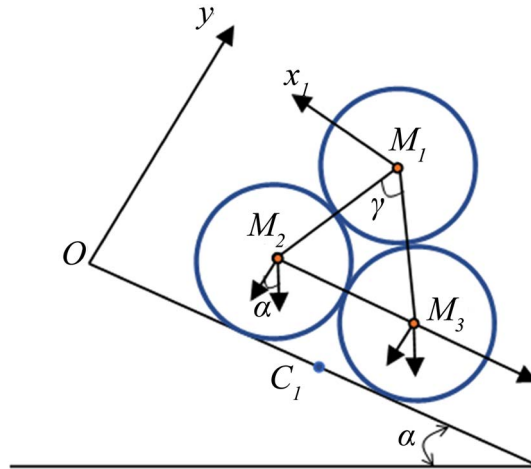


Figure 2. Scheme of three seeds on the crust.

3. Theoretical Studies of the Movement of Seeds

As generalized coordinates, we accept the angle φ and X between M_1O_1 and M_1M_2 vectors. With respect to the XOY coordinate system, the center of cylinders is determined by following formula:

$$\begin{aligned} X_1 &= X; & Y_1 &= h_0 + l \cos \varphi; \\ X_2 &= X - l \sin \varphi; & Y_2 &= R; \\ X_3 &= X + l \sin \varphi; & Y_3 &= R; \end{aligned} \tag{1}$$

The seeds are affected by the interaction force in areas where they are bonded together and in areas where the bottom seeds are attached to the plain [7].

The projection of the forces affecting the upper seeds will be as follows:

$$X_1 = m_1 g \sin \lambda + f_1 m_1 g \cos(\varphi - \lambda) \cos \varphi - f_1 m_1 g \cos(\varphi + \lambda) \cos \varphi; \tag{2}$$

$$Y_1 = -m_1 g \cos \lambda + f_1 m_1 g \cos(\varphi - \lambda) \sin \varphi + f_1 m_1 g \cos(\varphi + \lambda) \sin \varphi;$$

Lower seeds also have the following:

$$X_2 = -m_2 g \cos(\varphi - \lambda) \sin \varphi + f_1 m_1 g \cos \varphi + m_2 g f_2 \cos \lambda; \tag{3}$$

$$Y_2 = m_1 g \cos|\varphi + \lambda| \cos \varphi - f_1 m_1 g \cos(\varphi + \lambda) \sin \varphi - m_2 g f_2 \sin \lambda;$$

$$X_3 = m_1 g \cos(\varphi - \lambda) \sin \varphi - f_1 m_1 g \cos(\varphi - \lambda) \sin \varphi - m_2 g f_2 \cos \lambda; \tag{4}$$

$$Y_3 = -m_1 g \cos(\varphi - \lambda) \cos \varphi + f_1 m_1 g \cos(\varphi - \lambda) \sin \varphi - m_2 g f_2 \sin \lambda.$$

In this: f_1, f_2 —coefficients of friction and the friction of cotton seeds. Q_x, Q_y —to identify the aggregate forces $\delta_{x_1}; \delta_{x_2}; \delta_{x_3}; \delta_{y_1}; \delta_{y_2}; \delta_{y_3}$. Variations:

$$\delta_A = x_1 \delta_{x_1} + x_2 \delta_{x_2} + x_3 \delta_{x_3} + y_1 \delta_{y_1} + y_2 \delta_{y_2} + y_3 \delta_{y_3};$$

Hereby, we (1) shall have the following:

$$\delta_{x_1} = \delta_x; \delta_{x_3} = \delta_x - l_1 \cos \varphi \delta \varphi; \delta_{x_2} = \delta_x + l_1 \cos \varphi \delta \varphi;$$

$$\delta_{y_1} = -l \sin \varphi \delta \varphi; \delta_{y_2} = 0; \delta_{y_3} = 0.$$

δ_A the expression for the following appears:

$$\begin{aligned}\delta_A &= x_1 \delta_{x_1} + x_2 (\delta_x - l \cos \varphi \delta \varphi) + x_3 (\delta_x + l \cos \varphi \delta \varphi) + y_1 (-l \sin \varphi \delta \varphi) \\ &= (x_1 + x_2 + x_3) \delta_x + (-x_2 l \cos \varphi - y_1 l \sin \varphi + x_3 l \cos \varphi) \delta \varphi.\end{aligned}$$

$Q_x; Q_y$ — we define generalized forces and their δ_x and δ_y coefficients:

$$Q_x = x_1 + x_2 + x_3;$$

$$Q_y = l(-x_2 \cos \varphi - y_1 \sin \varphi + x_3 \cos \varphi)$$

(2), (3) and (4) x_1, x_2, x_3, y_1 after setting values we get the following:

$$\begin{aligned}Q_x &= m_1 g \sin \lambda + m_1 g \sin \lambda [\cos(\varphi - \lambda) - \cos(\varphi + \lambda)] \\ &= m_1 g \sin \lambda + m_1 g \sin^2 \varphi \sin \lambda\end{aligned}\quad (5)$$

$$Q_y = l \{ [m_1 g \cos(\varphi + \lambda) \sin \varphi - f_1 m_1 g \cos(\varphi + \lambda) \cos \varphi - m_2 g f_2 \cos \lambda] \cos \varphi$$

To create an equation of motion we find the kinetic energy of the system: $T = T_1 + T_2 + T_3$; where T_1, T_2, T_3 — kinetic energy of the first, second and third seeds respectively [8] [9].

$$\begin{aligned}T_1 &= \frac{m_1}{2} (\dot{x}^2 + l^2 \dot{\varphi}^2 \sin^2 \varphi); \quad T_2 = \frac{m_2}{2} (\dot{x} - l \dot{\varphi} \cos \varphi)^2 \\ T_3 &= \frac{m_3}{2} (\dot{x} + l \dot{\varphi} \sin \varphi)^2\end{aligned}\quad (6)$$

Total kinetic energy equals:

$$\begin{aligned}T &= \frac{m}{2} (\dot{x}^2 + l^2 \dot{\varphi}^2 \sin^2 \varphi) + \frac{m^2}{2} [(\dot{x} - l \dot{\varphi} \cos \varphi)^2 + (\dot{x} + l \dot{\varphi} \sin \varphi)^2] \\ &= \frac{m}{2} (\dot{x}^2 + l^2 \dot{\varphi}^2 \sin^2 \varphi) + \frac{m^2}{2} (2\dot{x}^2 + 2l^2 \dot{\varphi}^2 \cos^2 \varphi) \\ &= \frac{m_1}{2} (\dot{x}^2 + l^2 \dot{\varphi} \sin \varphi) + m_2 (\dot{x}^2 + l^2 \dot{\varphi}^2 \cos^2 \varphi)\end{aligned}$$

This equation is integrated with Runge-Kutta method on the following initial conditions:

$$\text{when } t = 0 \text{ then } \varphi = \varphi_0, \dot{Y} = 0$$

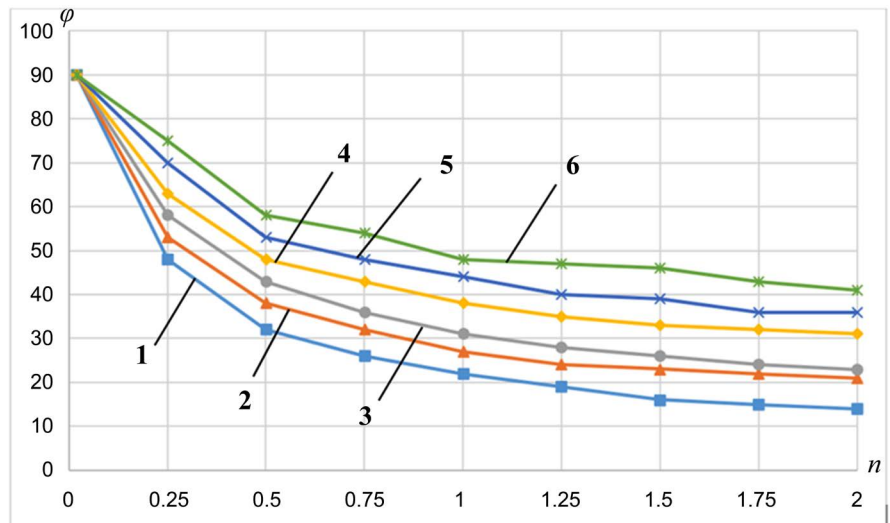
in this: $\varphi_0 < \varphi_{np}$, φ_{np} — the boundary angle to start the movement. It is determined by the equation: $A(\varphi_0) = 0$; $B(\varphi) = 0$.

Figure 3 shows diagrams of the separation of seed fractions under various process parameters, which show that all the graphs are descending, which corresponds to reality. At the same time, the intensity of separation is more noticeable with a low coefficient of friction, and with increasing coefficient of friction the intensity decreases substantially. However, the friction coefficient is an objective factor and it is not possible to control it during seed sorting. It should be taken as it is in fact and controlled by changing other parameters, for example, the slope angle, amplitude and frequency of the oscillating screen surface.

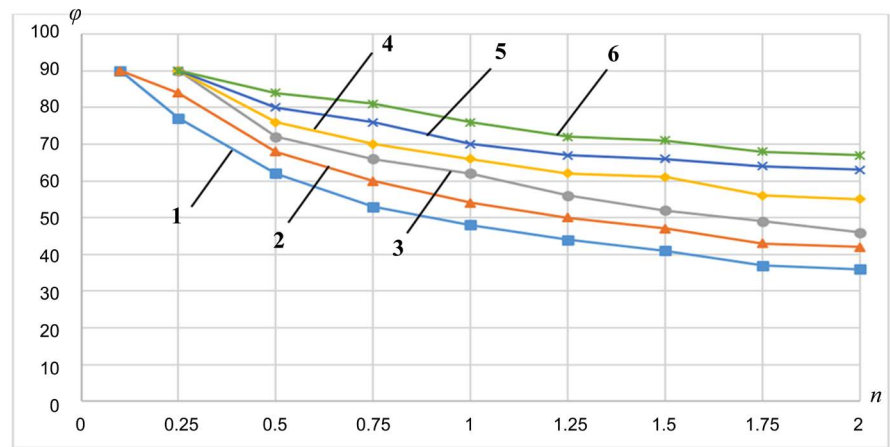
To solve the Equation (6) by the Runge-Kutta method, an exposure program has been created. The following conditions have been met for as account [10]:

$$\lambda = 10^0;$$

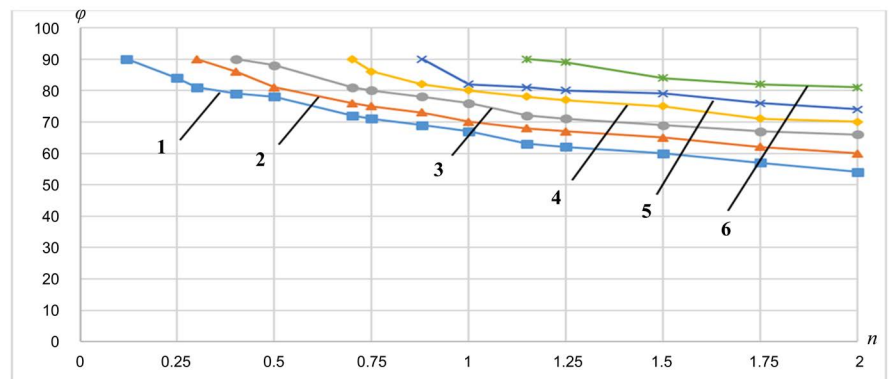
$$d = 10\text{mm};$$



(a)



(b)



(c)

Figure 3. Three seeds recession diagrams: (a) $f_0 = 0,1$; (b) $f_0 = 0,3$; (c) $f_0 = 0,6$; 1- $f = 0,1$; 2- $f = 0,2$; 3- $f = 0,3$; 4- $f = 0,4$; 5- $f = 0,5$; 6- $f = 0,6$.

$$n = 1; f_1 = 0.5; f_2 = 0.5; \varphi = 59^{\circ}$$

Figure 4 presents the results of solving Equation 6, which show that the

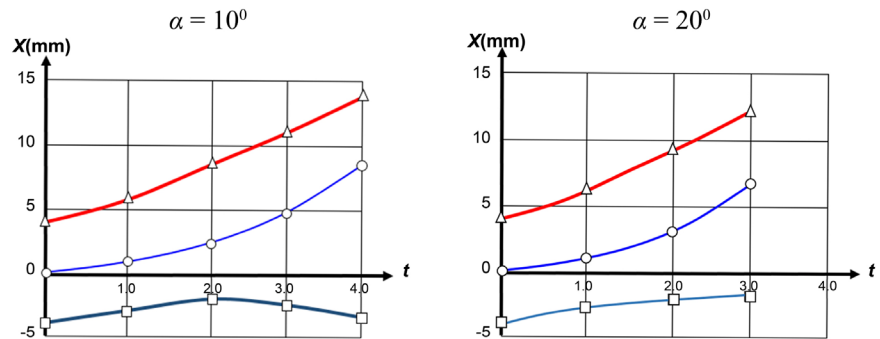


Figure 4. A timetable of movement of seeds to the surface over time $\alpha = 10^\circ$, $\alpha = 20^\circ$.

coordinates of the location of the seeds on the screening surface in time are basically of an ascending nature. And this shows that with these parameters, the seeds on the surface of the grid are moved and the sorting process is possible.

2—there are graphs of seeds in non-linear values, obtained from the calculation of the seed residence time on a perforated surface. The theoretical calculations allowed the following conclusions. The time of movement of the top cotton in the lower plain depends on the angle of the surface, the friction coefficient for the seeds on the surface, the friction coefficient of the seeds and the initial state of the seeds.

4. Conclusions

Comparison of the results of the calculations with the vibration shows that the vibration of the plain helps to move the seeds together, resulting the 1.5 ... 2.0 times decrease in upper cylinders reaching the plain.

Thus, our studies recorded the main parameters that determine the process of vibrational sorting, which showed that the most effective sorting occurs at an amplitude of $A = 17$ mm, frequency of $f = 4c^{-1}$, and the thickness of the seed layer does not exceed $h = 30$ mm.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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