

## RESULTS OF THEORETICAL AND PRACTICAL STUDY OF THE TECHNOLOGICAL PROCESS OF THE DEVELOPED HEAVY MIXTURE HOLDER

<sup>1</sup>Abdukholikov A.U

<sup>1</sup>Termiz State University of Engineering and Agrotechnologies. Termez, 190100, Uzbekiston

<sup>2</sup>Fiber Crops Research Institute. Tashkent, 111202, Uzbekiston

**Abstract.** *The article presents the theoretical study results on the effect of a softening long-pinned drum used in the holder of developed heavy mixtures. It analyzes the forces acting on cotton tufts when they strike the long-pinned drum after being transported through a pneumatic pipe. The motion of the cotton tufts and the efficiency of separating heavy mixtures from their composition are shown through equations and graphs. Specifically, considering the operating conditions of equipment used in cotton-cleaning enterprises and the pneumatic transport system—where the flow rate and air velocity at the inlet pipe are approximately 5 m<sup>3</sup>/s and 40 m/s, respectively—the speed of the transported cotton tufts ranges mainly between 18 and 25 m/s, depending on their size and weight.*

### Introduction

According to the developed technical solution, in order to increase the efficiency of pre-softening of cotton raw material in the heavy admixture holder and enhance the effect of its impact on the reflecting wall, it was recommended to place it on the lower guide wall of the chamber, opposite the reflecting wall, so that the cotton raw material first hits the softening drum, thereby ensuring that the cotton is first softened and then hits the reflecting wall. This requires new theoretical and experimental approaches in primary cotton processing<sup>1</sup>. Cotton is a key natural fiber in textiles, and its quality is crucial. Fiber quality depends on pre- and post-harvest practices. After harvesting, cotton is ginned to separate fibers from seeds. Quality is also affected by variety, environment, and handling<sup>2</sup>. This article studied the influence of the main input factors on the mass and density of raw material in the process of fiber separation, including the efficiency of the saw fiber separator (X1), the rotation speed of the auxiliary fertilizer device (X2), and the number of hairless seeds coming out of the auxiliary fertilizer device (X3).

### Experimental part

The tube (Fig. 1) consists of a chamber 3 consisting of guide 5 and reflective 2 walls and a box 8, to which inlet 7 and outlet 1 manifolds and a small hopper are connected, a vacuum valve 4 is located in the lower part of the chamber. Inside the chamber 3 there is a drum 6 with a long pile, a rotating valve is installed on the hopper wall in the bottom part of the reflecting wall 2 of the chamber 3.

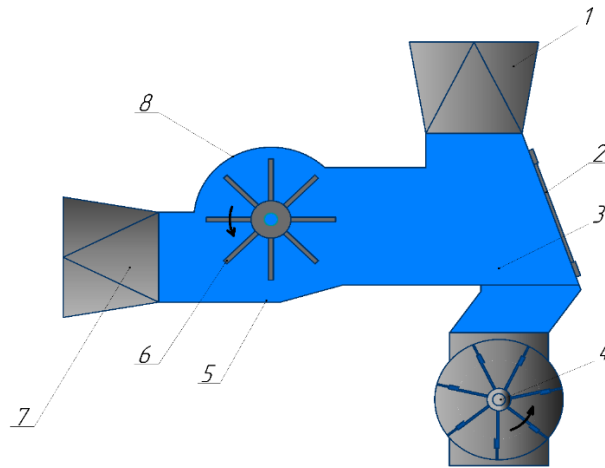


Figure 1. Scheme of the heavy mixture tester according to the proposed technical solution

The operation of the hopper is as follows. The inlet 7 and outlet 1 pipes along the air flow are connected to a pipeline system, the last part of which is connected to a fan through a cotton separator (not shown in the figure), which sucks air from the pipeline system, due to its pressure, the cotton raw material is transported from the pipeline system to the cotton separator through the hopper with heavy impurities. With the operating mode of the equipment used in cotton ginning plants and the pneumatic conveying device, the flow rate and air velocity in the inlet pipe are approximately 5 m<sup>3</sup>/s and 40 m/s, respectively, and the speed of the transported cotton pieces, depending on their size and weight, is mainly in the range from 18 to 25 m/s. The largest and densest cotton pieces move at a speed lower than these speeds, and individual flaps and small pieces consisting of several pieces move at a higher speed.

Due to the difference between the linear speed of the piles of the long-pile drum 6 and the speed of the cotton pieces transported by air, they are subjected to the impact of the piles, which ensures that almost all the cotton pieces are individually broken into small pieces and heavy impurities are separated from them<sup>11</sup>.

The reflection of cotton pieces and heavy impurities from the piles of the long-pile drum 6 depends on the height of the impact point on the deflecting wall 5. Basically, the reflection occurs in the direction of the deflecting wall 5, then the cotton pieces and heavy impurities, softened by the piles of the long-pile drum 6, are thrown by the expanding flow onto the reflecting wall 2. After hitting this wall, the pieces of cotton raw material are carried by the air flow to the outlet pipe 1, foreign heavy impurities fall into the hopper and are removed from the holder through the rotary vacuum valve 4.

Separated from the main flow and falling into the lower part of the chamber above the hopper, individual pieces of cotton raw material are removed by the air flow sucked through the holes of the rotary valve and returned to the main flow, which is transported to the outlet pipe 1, which prevents the cotton pieces from mixing with heavy impurities falling into the hopper of the hopper. In the first case, we will consider the action of removing foreign bodies from the composition of cotton raw material due to the installation of a drum with a long pile<sup>12</sup>.

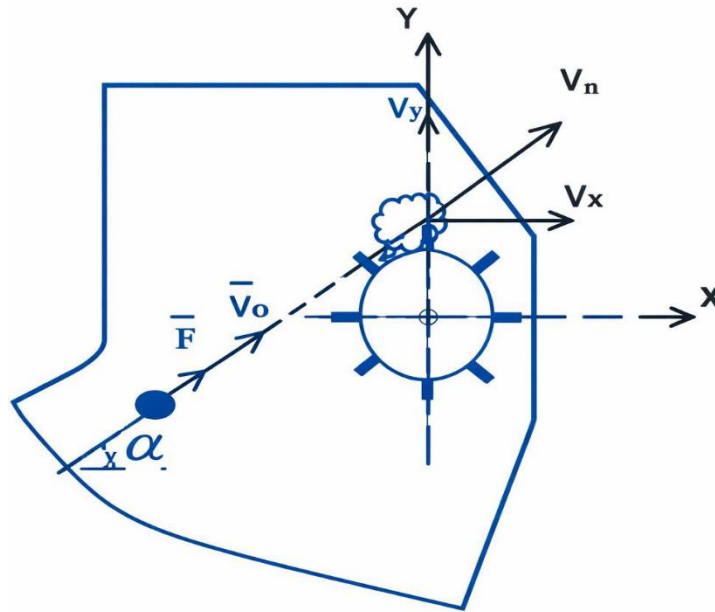


Figure 2. Scheme of the effect of a long-pile drum on the flow of cotton in the holder

Let the coordinate axes be located in the center of the drum with a long pile. Based on the D'Alambert principle, we make a formula for balancing a piece of cotton.

$$\begin{aligned}
 m \cdot \frac{d^2 x}{dt^2} &= R \\
 m \cdot \frac{d^2 y}{dt^2} &= -m \cdot g
 \end{aligned}
 \tag{1}$$

Here:  $m$  is the mass of the cotton ball,  $v$  is the velocity,  $g$  is the acceleration of gravity,

$R = k \cdot (\mathcal{G}_x - \mathcal{G}_n)$  - aerodynamic force,  $k$  - drag coefficient,  $\mathcal{G}_x$  - air speed,  $\mathcal{G}_n$  - the speed of the cotton ball.

By differentiating the formula (1), we determine the action of separating stones and various mixtures from a piece of cotton.

$$\begin{aligned}
 \frac{d^2 x}{dt^2} &= \frac{k}{m} \cdot (\mathcal{G}_x - \mathcal{G}_n) \\
 \frac{d^2 y}{dt^2} &= -g
 \end{aligned}
 \tag{2}$$

(2) by integrating the formula once, we determine the speed of the cotton flow in the axes.

$$\begin{aligned}
 \frac{dx}{dt} &= \frac{k}{m} \cdot (\mathcal{G}_x - \mathcal{G}_n) \cdot t + C_1 \\
 \frac{dy}{dt} &= -g \cdot t + C_2
 \end{aligned}
 \tag{3}$$

$C_1$  and  $C_2$  we use the initial condition to define the constant values

$t = 0 \quad \vartheta_x = \vartheta_0 \cdot \cos \alpha; \vartheta_y = \vartheta_0 \cdot \sin \alpha \Rightarrow C_1 = \vartheta_0 \cdot \cos \alpha; C_2 = \vartheta_0 \cdot \sin \alpha$  we put the fixed values of the constants in equation (3).

$$\frac{dx}{dt} = \frac{k}{m} \cdot (\vartheta_x - \vartheta_n) \cdot t + \vartheta_0 \cdot \cos \alpha$$

$$\frac{dx}{dt} = -g \cdot t + \vartheta_0 \cdot \sin \alpha \tag{4}$$

(4) we determine the displacement along the coordinate axes when separating stones and various mixtures from the cotton stream.

$$x = \frac{k}{m} \cdot (\vartheta_x - \vartheta_n) \cdot \frac{t^2}{2} + \vartheta_0 \cdot t \cdot \cos \alpha$$

$$y = -g \cdot \frac{t^2}{2} + \vartheta_0 \cdot t \cdot \sin \alpha \tag{5}$$

(5) Equilibrium shift in the separation of cotton particles. The speed of air and cotton particles entering the long pile drum is 400 rpm (8.33 m/s), 600 rpm (12.5 m/s) and 800 rpm (16.6 m/s), respectively. The graphs of the process of separating cotton pieces using equation (5) using the Maple program are presented in Figures 3 and 4.

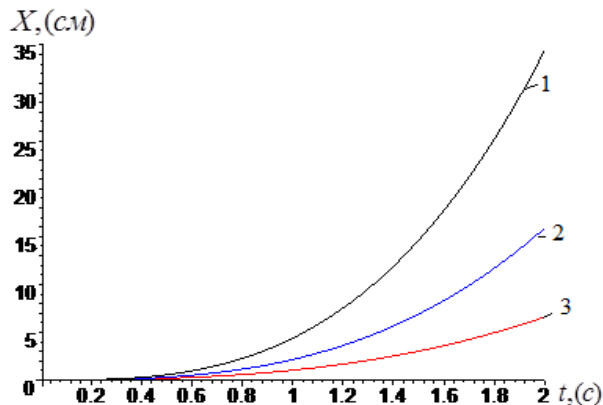


Figure 3. The speed of separation of various mixtures from the cotton stream is different  $\vartheta_{n1} = 16.6 \text{ m/s}$ ,  $\vartheta_{n2} = 12.5 \text{ m/s}$ ,  $\vartheta_{n3} = 8.33 \text{ m/s}$  graph of time dependence in values.

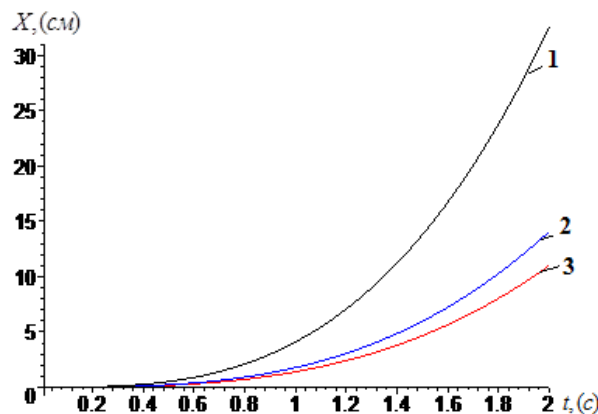


Figure 4. The length of the piles is different when separating different mixtures from the cotton stream  $l_1 = 20\text{ sm}$ ,  $l_2 = 15\text{ sm}$ ,  $l_3 = 10\text{ sm}$  graph of dependence on time in values.

As can be seen from the analysis of the graphs in Figures 3 and 4, the air velocity  $g_{n3} = 16,6\text{ m/c}$  drum with a long pile of cotton stream  $l_1 = 20\text{ cm}$  it is considered sufficient to transfer it to the diverter at the present value, in which it is possible to retain heavy impurities and thereby increase the efficiency of cleaning.

We present the analysis of the impact of external forces on the stone and various impurities separated from the cotton as a result of hitting the drum with a long pile of cotton.

### References

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