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Analysis of The Dynamics of Moving Cotton in Pipes

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Abstract
The passage of the pipe is the shells (turns), the Sprocket and the separator chambers, where the movement again goes out of balance, the cotton begins to move strongly wavy. Gradually, the trajectory of this movement also fades, when the passage of the pipe comes to the bottom, the movement moves again to an irregular appearance.

Keywords: cotton, pipe, movement, trajectory, balance, critical point, tape device.

Introduction

In world experience, great importance is attached to the development of the process, technology and technology of air transportation of cotton. In particular, improving the efficiency of the process of transporting cotton with pneumotransport, maintaining the initial quality indicators of cotton and reducing the energy consumption of the process, creating compact, simple, low material and energy-consuming structures of cotton transportation equipment, modern, automated, capable of managing the quality of products, as well as improving the quality of products by accelerating the introduction [1-7].]

Theoretical Works

Let the tape device be used when transferring cotton to the pipe of the carrier device using air (Figure 1):

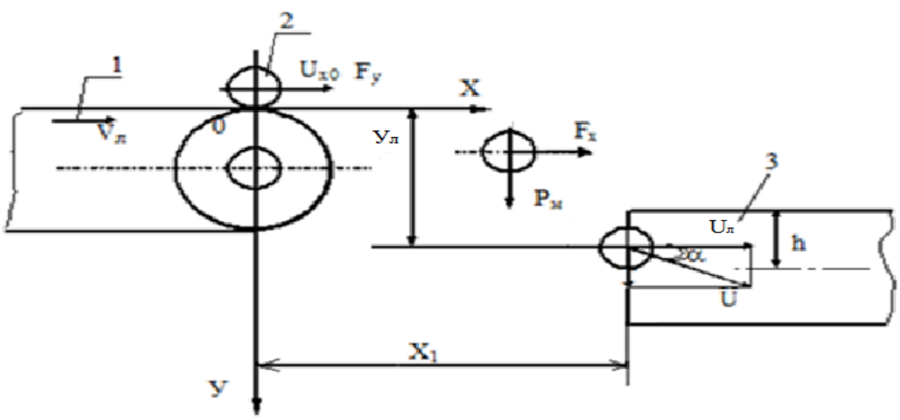

Figure 1. Scheme of the process of transferring cotton to the pipe of the carrier device using air using a tape device
1-horizontal tape device; 2-cotton swab; 3-pipe.

Let's take a look at the height of the XOY plain of a piece of cotton. First, we put the coordinate at the point where the contact of the tape with a cotton swab is interrupted [5-8]. The slice cut

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from the tape is affected by aerodynamic and weight forces. The equation of motion will look like this:

$$\begin{cases} m\dfrac{dU_x}{dt} = -F_x \\ m\dfrac{dU_y}{dt} = -F_y + P_м \end{cases} \quad (1)$$

there: m - is the slice mass, kg; U_x,U_y- the velocity of the slice on the coordinate axes is:
$F_x=k_pU_x$; $F_y=k_pU_y$, (2)
In this: F_x, F_y- aerodynamic forces against the junction of the coordinate axes of the bulkhead; $P_м = mg$ - weight force; g- free fall acceleration; k_p- aerodynamic resistance coefficient of a piece of cotton.
Putting the equation of the acting forces and solving the system, we obtain:

$$\frac{dU_x}{dt} = -\frac{k_n}{m}U_x$$
$$\frac{dU_y}{dt} = -\frac{k_n}{m}\left(U_y - \frac{mg}{k_n}\right) \quad (3)$$

equation solutions x, y - gives the velocities of the cotton swab on the coordinate axes. By integrating the solutions once in time, one obtains $y(t)$ and $x(t)$ - time from solutions t subtracting the results of $y = y(x)$ - we take the law of change of the movement of the cotton lump [9-11]:

$$y = -\frac{m^2 g}{k_n^2}\cdot\left[\ln\left(1-\frac{k_n\cdot x}{mU_{x_0}}\right)+\frac{k_n\cdot x}{mU_{x_0}}\right] (4)$$

By this law, we separate the cotton from the surface of the tape and build a graph of the trajectory of movement up to the pipe (Figure 2)

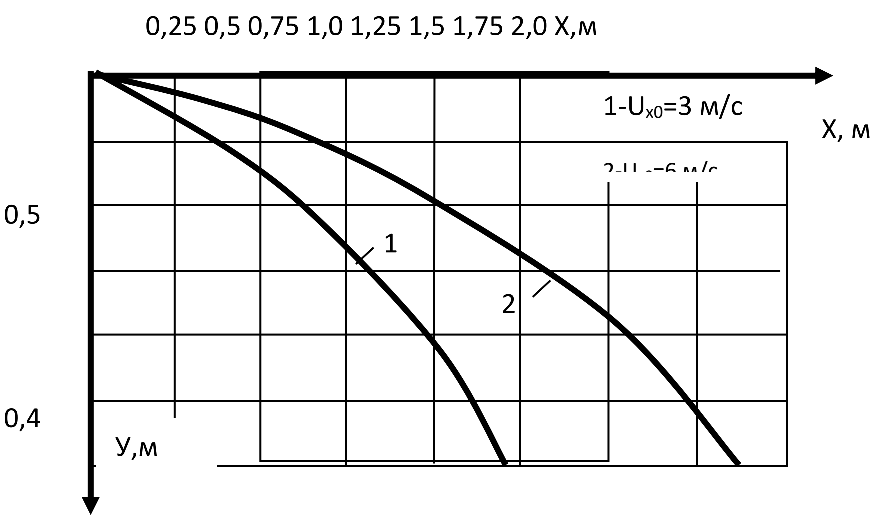

Figure 2. The trajectory of the cotton up to the pipe

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Figure 2 depicts the trajectory of the movement of a piece of cotton prior to its arrival in the pipe of the carrier device using air. As can be seen from the graph, the growing trajectory after the fragment is separated from the surface of the tape is longitudinal, in which, at a small initial speed, the fragment comes to the pipe with a small speed, at a large speed-on the contrary [12-14].

At the time of studying the movement of cotton in the pipe absorber, so that it is convenient, we first put the coordinate at the beginning of the pipe. Suppose that the movement of a piece is taking place between two Infinite walls:

u=0 va u=d.

Let's assume that a piece of cotton during a meeting with an air flow has an absolute speed, moving it at a certain angle relative to the pipe axis. Then the equation of motion becomes:

$$\begin{cases} mx'' = -k(x' - V) \\ my'' = ky' - mg \end{cases} \qquad (5)$$

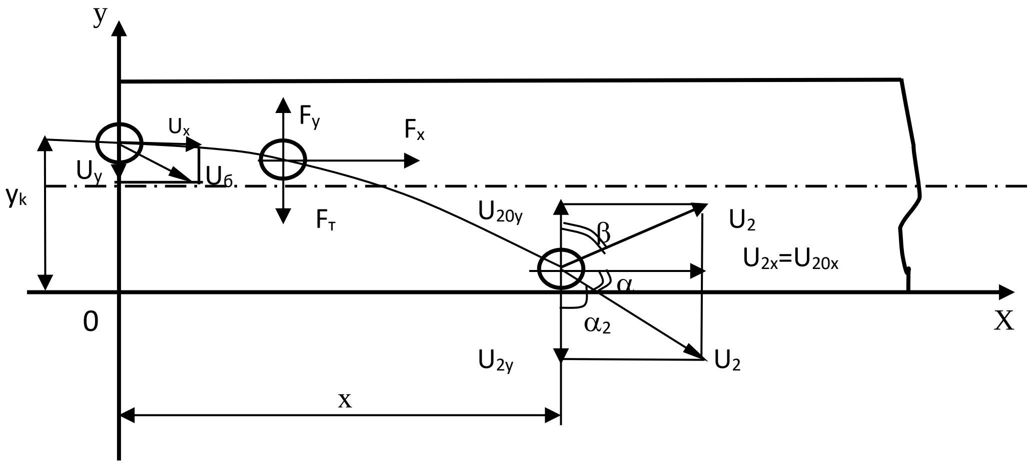

Figure 3. Scheme of the movement of cotton in the pipe

$U_x = \frac{dx}{dt}$ and $U_y = \frac{dy}{dt}$ considering the, we integrate the system under the condition t = 0. The solution would be:

$$\begin{cases} x = \frac{m}{k}(U_H \cos\alpha - U)(1 - e^{-\frac{k}{m}}) + Vt \\ y = -\frac{m}{k}(U_H \sin\alpha - \frac{mg}{k})(1 - e^{\frac{k}{m}}) + \frac{mg}{k}t + y_1 \end{cases} \qquad (6)$$

This system of equations determines the trajectory of cotton in the XOY plane.

At a certain distance (X), the piece collides with the inner wall of the pipe and is fired upwards under the influence of shock force.

From the analytical calculations, we determine the expression of the speed of the cotton piece after the stroke and its location on the coordinate axes (x, y):

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$$\begin{cases} U_x == (U_{20x} - V)l - \frac{k}{m}(t - t_1) + V \\ U_y = \left(U_{20y} - \frac{mg}{k}\right)l \frac{k}{m}(t - t_1) + \frac{mg}{k} \end{cases} \quad (7)$$

$$\begin{cases} X = \frac{m}{k}(U_{20x} - V)\left(1 - l - \frac{k}{m}(t - t_2)\right) + V(t - t_2) \\ Y = \frac{m}{k}\left(U_{20y} - \frac{mg}{k}\right)\left(1 - l\frac{k}{m}(t - t_2)\right) + \frac{mg}{k}(t - t_2) \end{cases} \quad (8)$$

In this:: $U_{20x} = (U_n \cos\alpha_1 - V)\frac{k}{m}t_2 + V \quad U_{20y} = U_{20x} x \cdot tg\beta$

Equations (7) and (8) determine the position of the splitter at the first stroke on the pipe wall. In this, the slice reaches the critical point and goes down. If the vertical coordinate magnitude of the critical point is greater than the diameter of the pipe, then the piece will hit the upper wall. The law of variation of the trajectory of a Y=y(t) - cotton swab over the diameter and length of the pipe is graphically illustrated by the exclusion of time.

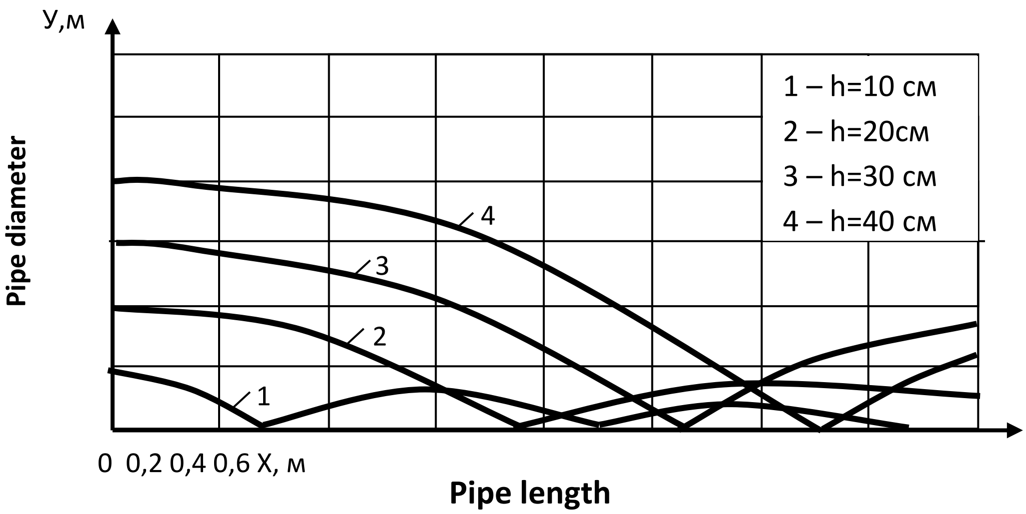

Figure 4. Motion trajectory of cotton in a pipe

Conclusion

An interesting case can be observed from the results, that is, during the movement of a piece of cotton in a pipe, a collision of a piece with a blow to the wall of the pipe occurs, even without taking into account the turbulence of the flow, longitudinal, rotating and other forces. The larger the velocities in this, the faster and more intense the shock. Also, the motion of the cotton swab is Tolkien, and initially the amplitude of the wave is large, and after each hit on the pipe wall, the amplitude decreases, that is, the trajectory fades, and the movement becomes a rectilinear motion. However, this pattern continues to the pipeline's passages, except for.

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