Theoretical Study of the Movement of a Piece of Cotton on the Surface of the Grid in the Process of Separating Large Impurities from Raw Cotton

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Abstract: ***Purpose.*** *Construction of a mathematical model of the process of separation of large impurities from raw cotton moving on the surface of the grate.*

Methods*. It was suggested to use AG Sevastyanov's model in the process of cleaning cotton from contaminants.*

Results. *According to the results, the maximum amount of contaminants was detected between the first and third ribs, and a decrease was observed in the next ribs. This means that the condition of the length of the contact zone between the raw cotton and the surface must be taken into account.*

Conclusion. *The results obtained are based on the analysis and the calculation results are performed at these values of the parameters* $R = 0.204m$, $\rho_0 = 25kg/m^3$, $f_1 = 0.2$, $\varphi_0 = 30^0$, $\alpha = 120^0$, $Q_0 = 3500 - 4000kg/hour$, $L = 1.3m$, $h = 0.02m p_0 = 20Pa$, $k = 3$

Keywords: *Seed, cotton, dirty mixture, ribbed grid, efficiency, density, strength, speed, vibration*

Introduction

In the process of processing raw cotton, it is necessary to remove impurities (crushed leaves and flower residues, twigs, and). Contaminants larger than 8 mm are divided into large and small contaminants. Contamination of raw cotton is determined by quantitative and qualitative indicators. While the quantitative indicator determines the total amount of impurities in the raw material (in units and percentages), the quality indicators characterize the amount of impurities, their binding to the fibers in the cotton pieces. The impurities are on the surface of the cotton pieces, on the inside, and their raw material particles are mixed to varying degrees. Therefore, fine impurities are deeply embedded in the raw material, and their separation from the particles requires more complex methods, mainly mechanical shock.

Large contaminants are mainly located on the surface of the raw material springs, and their separation from the fiber is not a big problem because they are more loosely bound to the fiber. Before we get acquainted with the design of cottonseed waste, equipment and devices, we will get acquainted with the essence of the content of the waste fiber binding, the effectiveness of their cleaning. In addition, we will consider the basic control developments and calculation processes in the selection of technological parameters of cleaners.

At present, the process of cleaning raw cotton from waste is based on the impact and dragging of cotton pieces from the rough surface. The main purpose of the purifier is to reduce the bonding force between the waste particle and the fiber under the influence of dynamic forces (shock, vibration, shaking and x, k), to move the particle relative to the raw material and to remove it from the raw material mass. Such processes play different roles in waste mobilization. Impact force is the most basic method and is a key part of the cleaning process. In addition to the positive side, consider the negative effects of impact force.

For example, if the impact force is too high, it can damage the fibers and seeds, or the large contaminants in the composition can turn into small contaminants. Therefore, it is recommended to use the impact force in moderation. Another way to intensify the movement of contaminant particles is to create vibrations in the raw material, thus gradually reducing the bonding force between the contaminant particles and the fiber over a period of time.

This method is considered in the theory of vibration to reduce the friction force, to have a targeted effect on the particles of dirt. Cleaning efficiency, seed friction and cotton wrapping. If we assume that the weight of the initial impurities in the cotton is the weight of the impurities separated by the cleaner, then the cleaning efficiency is calculated as follows;

$$K = \Delta cn 100\% / g_1 \qquad (1)$$

If the weight of the initially selected cotton is taken as the weight of the impurities on the surface, then the relative pollution relative to the weight

$$C_1 = g_1 100\% / G_1$$

is equal to Using this expression, we write as follows

$$k = \frac{\Delta cn * 100}{g_1 G_1} 100\% \qquad (2)$$

will be displayed. If we take the relative impurity of the cotton removed from the ginner and its (cotton) weight, then the following equation is valid.

$$G_1 C_1 = G_2 C_2 + 100\Delta cn \qquad (3)$$

Using (2.29) we write the formula (2.30) using the relative impurities in the cleaned cotton

$$k = \frac{\Delta cn 100\%}{\frac{G_2 C_2}{100} + \Delta cn}$$

In practice, relative impurities and s are known, so it is recommended to calculate the cleaning efficiency using this simple formula

$$k = \frac{(C_1 - C_2)100}{C_1(100 - C_2)}$$

The following empirical formula is recommended for the seed damage index M. In our research, we will analyze the equations of the trajectory of the saw drums relative to the ribbed grid in the cotton ginning machine, as well as the theoretical basis of the adhesive brush and brush drums for removing raw cotton.

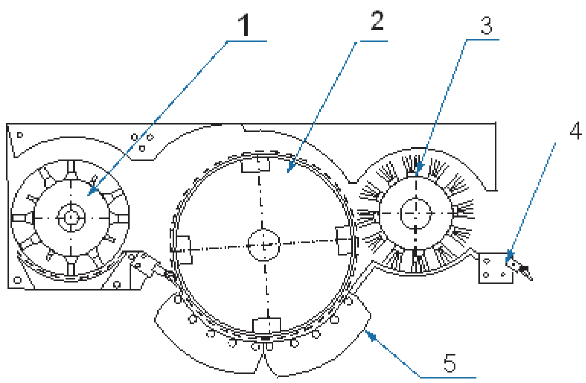


Figure 1. Cleaning scheme of large contaminants.

1-pile drum, 2-saw drum, -3-brush drum, 4-fastening brush, 5-ribbed grille.

After the raw cotton in the heaviest contaminant passes through the first row of the ribbed grate, the saw drum moves away from the grate. The cotton ball in the drum has the maximum distance, ie it is not affected at the longest distance, so it is advisable to install the next column.

During the cleaning process, the cotton piece is cleaned of large contaminants as a result of the maximum distance from the surface of the saw drum under the action of centrifugal force, which shakes it completely when it hits the ribbed grids. It is not advisable to increase the distance between the steps, as this will lead to the addition of raw cotton to the waste and the increase of cotton in the waste.

In practice, in determining the law of distribution of density by arc, it is necessary to take the raw material on the basis of the flow of the surrounding medium and construct its equation of motion. In addition, the law of conservation of mass (for a state of stationary motion) and the equation of state of the environment must be involved. Based on this principle, we accept the following assumptions as an environment for the connection of raw cotton;

1.The thickness of the medium is constant along the arc $h = R_2 - R_1$, very small relative to the radius of the drum ($h << R_1$), its motion has a one-dimensional velocity along the arc v and stationary (Fig. 2) and the mass of pollutants released from the environment does not affect the total raw material consumption. In this case, the law of conservation of mass is appropriate for the environment:

$$\rho v S = Q_0 \qquad (4)$$

Where r is the ambient density, S = Lh is the cross-sectional area of the raw material layer, h is the layer thickness, L- is the drum length, and Q_0 is the raw material consumption.

2. Flow velocity, pressure and density are determined at any distance from the arc of the midline of the thickness of the medium

3. The state equation of the raw material environment is expressed by a linear relationship between its density r and pressure pores

$$\rho = \rho_0[1 + A(p - p_0)] \qquad (5)$$

Here $\rho_0$and ρ_0 are the natural density of the raw material and the pressure in it, which is determined experimentally.

Place the coordinate head in the center of the drum and orient the 0x axis from left to right and the 0x axis perpendicular to it from top to bottom (Figure 2). Based on the above assumptions, we obtain the equation of motion of the raw material flow along the arc ABC. From the current with polar coordinates $(r = OR, \phi)$ we separate the element ds at any distance $s = R(\phi - \phi_0$ from point A and formulate the equation of equilibrium, taking into account its inertial force in the stationary state.

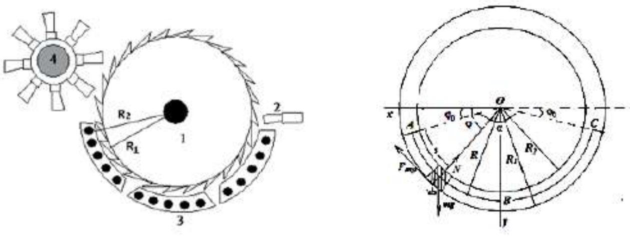


Figure 2. The scheme of movement of the raw material along the arc of the grate $\varphi_{i+1}+\alpha$

In this case, we assume that the columns are continuous along the grid. Using Figure 2, we can determine the forces acting on an element along the unit length of the grid. Let the current flow in a positive direction from point A to point C. These forces are defined as follows:

1. According to the projection of the force of gravity on the positive direction of the arc:

$$F_g = \rho g \sin\varphi$$

2. Projection of the frictional force created by the force of gravity of the element:

$$F_{1тр} = -f_1 \rho g \cos\varphi$$

3. Friction force along the arc of a grid generated by centrifugal force:

$$F_{2tr} = -f_1 v^2/R$$

4. Coulomb friction force proportional to the pressure between the drum teeth and the raw material flow:

$$F_{3tr} = -\tau/s_0$$

Here:

f_1 and f_2 coefficients of friction on grille and drum surfaces,

τ - the force exerted by the drum on the raw material,

s_0 g - the length of the grid arch

Given the above forces, we write the Euler equation for the stationary motion of the current

$$\rho v \frac{dv}{ds} = -\frac{dp}{ds} + \rho g(\sin\varphi - f_1 \cos\varphi) - f_1 \rho \frac{v^2}{R} + \frac{\tau}{s_0}$$

(6)

Equation (2.30) is unknown along with connections (2.31) and (2.32). and serves to identify (2.33) above equation. Substituting the expressions for the pressure, we obtain the following equation for determining the pressure

$$\frac{dp}{d\varphi} = F_1(\varphi) p + F_2(\varphi) \qquad (7)$$

Here:

$$F_1 = \frac{A[F_0(\varphi) + f_1 \bar{Q}_0 v_0]}{1-a},$$

$$F_2 = \frac{F_0(\varphi) - f_1 \bar{Q}_0 v_0}{1-a} - \frac{A[F_0(\varphi) + f_1 \bar{Q}_0 v_0]}{1-a} p_0 + \frac{\tau R}{s_0(1-a)}$$

,

$$F_0 = \rho_0 g R(\sin\phi - f_1 \cos\phi),\ a = \bar{Q}_0 v_0 A,$$
$$\bar{Q}_0 = Q_0/Lh$$

$p(\phi_0) = p_0$ the solution of the equation that satisfies the condition is as follows

$$p = \exp[F_3(\phi)]\{p_0 \exp[-F_3(\phi_0)] + \int_{\phi_0}^{\phi} F_2(x)\exp[-F_3(x)]dx\} F_3 = \int F_1(\phi)d\phi \ (8)$$

The density and flow rate of the raw material are calculated using these formulas

$$\rho = \rho_0[1 + A(p - p_0)], v = v_0/[1 + A(p - p_0)] \approx v_0[1 - A(p - p_0)]\ (A << 1) \quad (9)$$

The decrease in the mass of raw material along the arc of a single grid in the cleaning zone is represented by the formula AG Sevostyanov [1] (9 according to the following formula p (kg / m3)

$$\frac{m}{m_0} = \left(\frac{\rho}{\rho_0}\right)^{\lambda}$$

If the number of grids is k, then the following formula is proposed

$$\frac{m}{m_0} = \left(\frac{\rho}{\rho_0}\right)^{\lambda k}$$

using the formula

$$\frac{m}{m_0} = \left(\frac{\rho}{\rho_0}\right)^{\lambda k} = \frac{1}{[1 + A(p - p_0)]^{\lambda k}} \approx [1 - A(p - p_0)]^{\lambda k}$$

determine the cleaning efficiency

$$\varepsilon = \frac{m_0 - m}{m_0} = 1 - [1 - A(p - p_0]^{\lambda k} \qquad (10)$$

The amount of impurities released from the raw material is calculated by this integral

$$M = m_0 \int_{\phi_0}^{\phi_0+\alpha} [\{1 - [1 - A(p - p_0)]^{\lambda k}\} d\phi$$

The calculation results were performed at these values of the parameters

$$R = 0.204m, \rho_0 = 25kg/m^3, f_1 = 0.2,$$
$$\phi_0 = 30^0, \ \alpha = 120^0, Q_0 = 3500 - 4000kg/chas,$$
$$L = 1.3м, h = 0.02m, p_0 = 20Pa, k = 3$$

Table 1 shows the ratio (in percent) of the initial mass of the raw material at different values of the coefficient $A(Pa^{-1})$of impurities separated from the raw material when $\tau = 20Pa\tau = 40Pa$listed.

Table 1: Values of the mass of impurities separated from the raw material

$\tau = 20Pa$

$A(Па^{-1})$	0.002	0.0025	0.00275	0.0030	0.00325	0.0035	0.00375	0.004	0.00425	0.0045
$\frac{M}{m_0}100$	0.567	2.05	3.08	4.36	5.98	5.97	7.83	13.12	16/87	17.1

$\tau = 40Па$

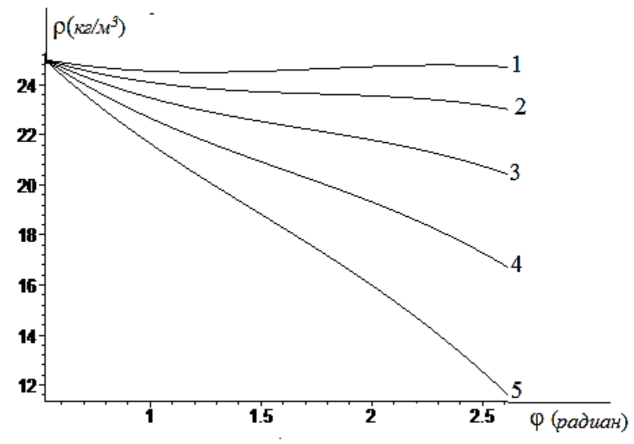
$A(Па^{-1})$	0.002	0.0025	0.00275	0.0030	0.00325	0.0035	0.00375	0.004	0.00425	0.0045
$\frac{M}{m_0}100$	0.26	1.64	2.6	3/8	5.27	5.26	7,00	12	15.5	15/6

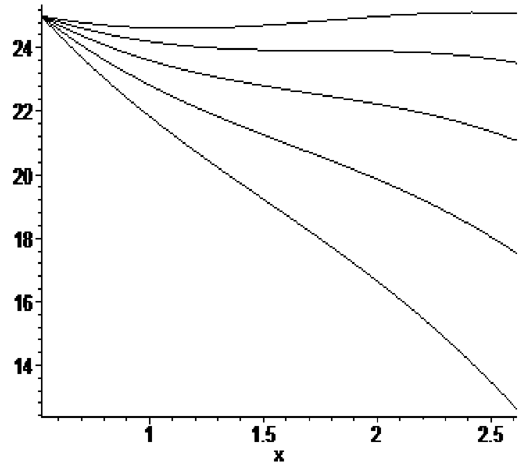
In Figure 3, the raw material density ($\rho(kg/м^3)$), V (м/с) velocity, and cleaning efficiency at two different values of the test voltage τ_0(Pa)and the coefficient $A(Pa^{-1})$The distribution graphs along the surface of the grate grate are given.

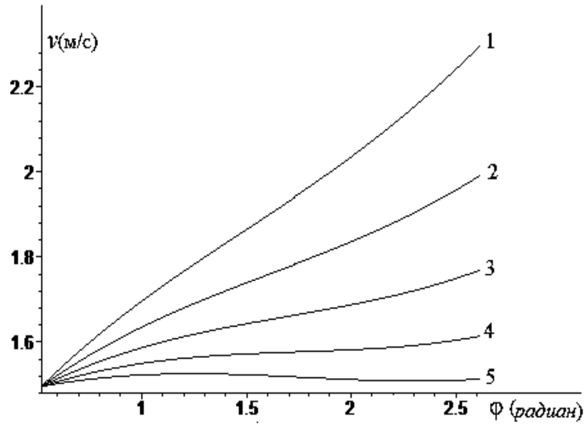
From the analysis of the given graphs it is observed that when the slope coefficient A increases, the density p and the laws of arc distribution of the cleaning efficiency e change.

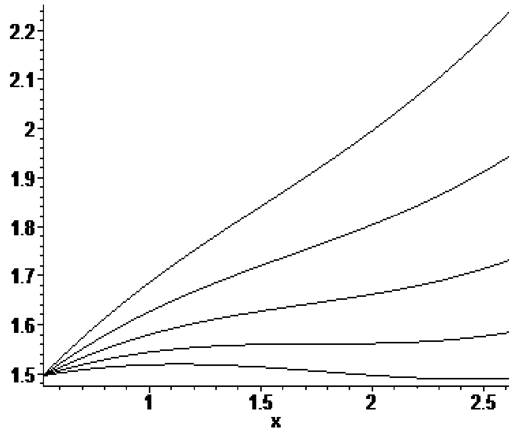
In its small values, the density decreases to the minimum in the obtained interval with increasing decrease in the obtained interval. and efficiency is maximized. This law allows the selection of the coefficient of inclination of the raw material environment in which the separation of raw materials from impurities

$\tau = 20Па$ $\tau = 40Па$









Conclusion

In determining the law of arc distribution of the density of cotton on the surface of the grate with an saw drum, the structure of the equation of motion of the cotton is taken on the basis of the ambient flow, and this equation is the equation of pressure, density and velocity In addition, the law of conservation of mass and the equations of state of the environment are given to supplement it, and in the calculation it was proposed to use the AGSevastyanov model in the process of cleaning cotton from impurities.

The highest amount of contaminants was detected between the first and third ribs, and a decrease was observed in the next ribs. This means that it is necessary to take into account the state of the length of the contact zone between the raw cotton and the colasnik surface. The results of the calculations are performed at these values of the parameters.

$$R = 0.204\text{м},\ \rho_0 = 25 кг/м^3,\ f_1 = 0.2,$$

$$\varphi_0 = 30^0,\ \alpha = 120^0,\ Q_0 = 3500-4000\text{кг/час},$$

$$L = 1.3\text{м},\ h = 0.02\text{м},\ p_0 = 20\text{Па},\ k = 3$$

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