THEORETICAL STUDY OF THE PROCESS OF SEPARATION OF HAIRLESS SEEDS FROM SEED FIBRE

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Abstract
A theoretical study of the process of movement of a dehydrated seed + fibrous medium in a saw gin roll box has been carried out. The process representing the motion of a depleted seed + fibrous medium is mathematically constructed, based on which the corresponding differential equations are constructed. The constructed differential equations were solved numerically in the MAPLE-17 program, corresponding graphs were obtained and conclusions were given.

Keywords: Cotton, gin stand, seed, fibre, mathematical model, saw, roll box, seed roller, speed, quality, efficiency, pressure, density, strength.

Introduction
In the technology of primary processing of cotton, one of the main issues is the process of separating the seeds from the fibres and removing them from the raw material shaft. This is because more than 30% of the hairy and hairless seeds separated from the fibres are collected in the centre of the raw material roller [1-7]. This in turn leads to an increase in the density and internal pressure of the raw material roller. As a result, the rotational motion of the raw material roller is slowed down and in turn, the ginning process is negatively affected [8-11].
Therefore, the authors proposed a new design of the working chamber to increase the efficiency of the ginning process. Horizontal bars are opened from the left inner surface of the working chamber. In this case, due to the rotational movement of the raw material roller, a certain part of the degreased seeds leaves the working chamber through the grids from the seed + fibrous medium. This in turn increases the intensity of the ginning process. During the movement of a seed + fibre mass of known thickness along the surface of the mesh, a contact force is formed between the mesh surfaces, under the influence of which a flat and spatial motion occurs. As a result, a certain part of the hairless seeds that are not attached to the fibres

protrudes beyond the open areas of the mesh surface. A model was proposed by AG Sevostyanov to describe such a mechanism [12-19].

The Main Pair

According to the model proposed by AG Sevostyanov, the decrease in the number of seeds on the surface of the net is proportional to the amount of raw material roller and the speed of movement along the surface. Based on this model, we theoretically study the process of separation of non-fibrous seeds from the composition of the seed + fibrous medium. Before modelling this process, it is necessary to determine the velocity of the seed + fibrous medium on the mesh surface.

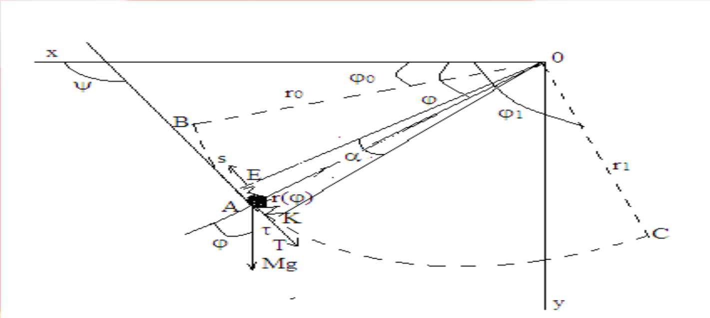

Figure 1. Scheme of motion on different surfaces of the particle

Once we know the law of velocity motion of the seed fibre along the inner full and lattice surface of the working chamber, we theoretically consider the process of separation of depleted seeds from the seed + fibre medium based on the model of AG Sevastyanov. Suppose that during the motion of a particle along a line, its mass decreases by and its mass decreases by, ie, by According to the model of AG Sevastyanov, its relative reduction should fulfil the following equation$BCM\Delta tdMM - dM$

$dM/M = -\lambda\dot{s}\bar{N}dt$ (1)

Here is the coefficient of proportionality.λ

$\bar{N} = N/M_0 g$,

N- normal power.

In the model of A.G. Sevastyanov, this force is not taken into account. If so, then there will be no process of separation of dehydrated seeds, because in this case the contact between the seed + fibrous medium and the mesh surface is broken. If the above model AG Sevastyanov is applied, then the condition must be checked.$N \leq 0 N > 0$

Integrating equation (1) with the condition (where - the initial mass of the seed + fibrous medium) we find$M(0) = M_0 M_0$

$$M = M_0 \exp\left(-\int_0^t \lambda\dot{s}(t)\bar{N}dt\right)$$

In particular, if the integral,, it is necessary to put the expressions:$r = r_0 = \mathrm{const}\, dt = \sqrt{\frac{r_0}{g}}\, d\tau \dot{s} = (\bar{v}_0 + \phi'_*)\sqrt{r_0 g}\bar{N} = (\bar{v}_0 + \phi'_*)^2 + \sin(\phi_* + \phi_0 + \bar{v}_0\tau)$

$$M/M_0 = r_0 \exp\left(-\int_0^\tau \lambda(\bar{v}_0 + \phi'_*)[(\bar{v}_0 + \phi'_*)^2 + \sin(\phi_* + \phi_0 + \bar{v}_0\tau)]d\tau\right),$$

If the AG Sevastyanov model is used:

$$M/M_0 = r_0 \exp\left(-\int_0^\tau \lambda(\bar{v}_0 + \phi'_*)\, d\tau\right) \qquad (2)$$

we will get the formula and will need to check the condition. This ratio is formed by equal to the number of seeds separated from the seed + fibrous medium$N > 0 M_0 - M$

$$\varepsilon = \frac{M_0 - M}{M_0} = 1 - r_0 \int_0^\tau \lambda(\bar{v}_0 + \phi'_*)[(\bar{v}_0 + \phi'_*)^2 + \sin(\bar{v}_0\tau + \phi_0 + \phi_*)]d\tau (3)$$

The initial conditions are that, according to the model (3) proposed above, the equation for the decrease in particle mass can be written in the following simple form$\phi_* = 0 \phi' = \bar{v}_0$

$$\frac{dM}{M} = -\lambda_0 \bar{v}_0(\bar{v}_0^2 + \overline{\sin \vec{v}_0}\ \tau)d\tau \qquad (4)$$

Here we find the conditional integral$M(0) = M_0$

$$M = M_0 \exp[-\lambda_0(\bar{v}_0^3\tau + 1 - \cos(\bar{v}_0\tau + \phi_0)] \qquad (5)$$

The formula for the theoretical calculation of the efficiency of separation of seeds from the composition of the seed + fibrous medium is as follows

$$\varepsilon = 1 - \exp[-\lambda_0(\bar{v}_0^3\tau + 1 - \cos(\bar{v}_0\tau + \phi_0)] \qquad (6)$$

Results and Discussion

2Figure -3 shows the law of variation in the reduction of the mass at the exit of the dehumidified seeds between the grids of the working chamber and their cutting efficiency in per cent, with different coefficients of proportionality. From the analysis of the graphs, we can see that an increase in the coefficient of proportionality accelerates the process of separation of dehydrated seeds from the composition of the seed + fibrous medium. And conversely as cutting efficiency increases in percentage.λλ

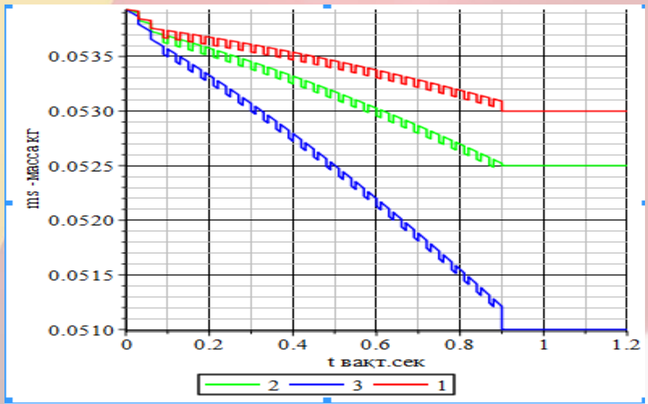

Figure 2. The law of change over time depends on the coefficient of different proportions - the decrease in the mass of dehydrated seeds at the exit between the grids of the working chamber. 1- = 0.02; 2- = 0.025; 3- = 0.03;λλλλ

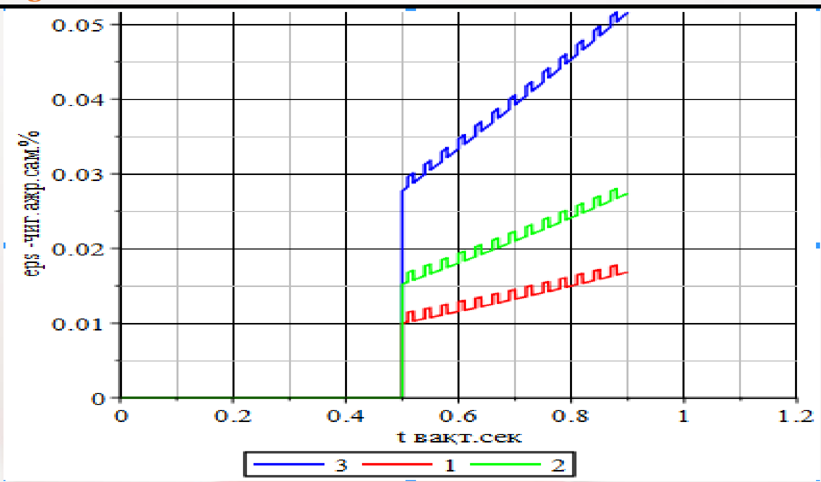

Figure 3. The law of change over time depends on the coefficient of different proportionality in per cent of the efficiency of cutting the seeds from the grids of the working chamber.1- = 0.02; 2- = 0.025; 3- = 0.03;λλλλ

Conclusion

A theoretical study of the process of movement of depleted seed + fibrous medium in the chamber of the gin shchi was carried out. The process representing the motion of a depleted seed + fibrous medium is mathematically constructed, based on which the corresponding differential equations are constructed. The constructed differential equations were solved numerically in MAPLE-17 and the corresponding graphs were obtained. The results show that the gin working chamber has a positive effect on the ginning process, which increases the efficiency of a certain part of the hairless seeds coming out of the grid holes in the new design.

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