Analysis of the vibrations of a console column made on a base with non-line protection in gin

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Abstract. The article presents a constructive scheme and the principle of operation of the cantilever grate of a saw gin installed in the housing by means of a rubber gasket consisting of two rubber elements having different stiffness. The results of the study show that when sawing raw cotton, the saws touch the working part of the chimneys, causing blockages, which leads to damage to the fiber, as well as a decrease in the overall quality of the fiber. In this case, the total stiffness was obtained with a nonlinear characteristic. A mathematical model and its solution by an approximate analytical method. A numerical solution of the problem constructed graphical dependencies and on the basis of their analysis, the necessary values were recommended.

1. Introduction

It is known that 4DP-130 and 5DP-130 gin machines are used in the process of separation of low-grade and medium-fiber cotton varieties grown in the country.

The main working part of the saw blades consisted of a saw cylinder, as well as a grid assembled from saw blades. As a result of the interaction of these two working parts with each other, the fiber is separated from the seed, i.e. the seed falling into the working chamber of the gin is hung on the rotating saw teeth on the cotton seed comb and dragged along the saw blade to the working part of the column. The fibrous seeds attached to the saw teeth attach to other fibrous seeds and pull them as well: in this order, as a result of the rotation of the saw and the adhesion of the fibrous seeds to each other, the cotton mixture begins to rotate in the working chamber. Thus a raw material roller is formed which rotates in the opposite direction to the rotation of the saw, which continuously supplies the saw teeth with fiber.

The fibers attached to the saw teeth are passed between the columns, and the seeds cannot pass through the space between the columns, at which point they are separated from the fiber (figure 1).

SCh15 cast iron chimneys are used in ginneries and linters, which are installed flat on the grate of the ginners and leave a hole for sawing between them.
The operation of the gin and linters shows that due to the inclination of the saws and the inaccuracies in the assembly of the grate, the contact of the saws with the saws leads to the rapid erosion of the saws. Erosion of the columns during processing leads to an increase in the gap between them, and as a result, the process of separating the fiber from the seed is disrupted [1, 2].

The use of the grate for only three months will result in 70-80% of the cracks between the grate exceeding the allowable amount. An increase in cracking leads to seed germination, mixing with the fiber after cracking, damage to the fiber during germination, and a decrease in its quality. Therefore, the working period of the columns is 4-6 months and requires frequent replacement. The main process in sawdust is the separation of the fiber from the seed [3]. The main requirement in this process is to reduce fiber, seed damage. It is also important to have sufficient fiber output at high performance. In order to meet these requirements at a high level, including in order to intensify the process, a column-mounted column construction with nonlinear strength was recommended [4, 5]. The construction scheme is shown in figure 2a.

During the ginning process, the cotton fibers are carried by the teeth of a cylindrical saw through a slit between the columns. The seed affects the colon. As a result, column vibrations occur. This accelerates the separation of the fibers from the seeds. Calculation schemes were developed in accordance with the vibrations of the column, and it is shown in figure 2. In this case, the column of mass $m_k$ is expressed by the coefficient of dissipation of the base $B$ and the coefficients $C_1$, $C_2$ which represent the nonlinear strength.

The impact force of cotton is expressed by $F_0 \sin \omega t$. It should be noted that as the resistance to fiber separation from the seed increases, so does the amplitude of vibration of the $m_k$ mass. In doing so, it can negatively affect the process of insanity. Therefore, it is expedient to select the base elastic coefficient of elasticity of the base as a nonlinear characteristic, i.e., as the external force increases, the intensity of the column displacement decreases. This leads to an acceleration of the ginning process (figure 2a).
The differential equation representing the vibration of a column when mounted on a support by means of a flexible element having a nonlinear characteristic strength is as follows:

\[ m_k \frac{d^2 x}{dt^2} + b \frac{dx}{dc} + c_1 x + \frac{c_2}{\mu} x^3 = F_0 \sin \omega t \]  

(1)

Where, \( m_k \) column mass; \( \mu \) is a non-linear constant coefficient; \( F_0 \) the force acting on a piece of cotton during the ginning process; \( C_1, C_2 \) are the coefficients of elasticity of the elastic base, \( b \) dissipation coefficient. The dissipation coefficient was not taken into account when solving the problem to estimate the maximum value of the vibration amplitudes. Using the existing method [6, 7], the approximate analytical solution of (1) is as follows:

\[ x = x_0 \sin \omega t - \frac{c_2 x_0^3}{32 \omega^2 m_k \mu} (\sin 3\omega t - \sin \omega t) \]  

(2)

In this case, the specific vibration frequency of the column is determined on the basis of from the following expression:
The numerical solution of the problem is performed at the following values of the parameters:

\[ m_K = (0.8 \pm 1.2) \, \text{kg}, \quad C_1 = (2.5 \pm 5.0) \times 10^4 \, \text{N/m}, \quad C_2 = (0.5 \pm 1.2) \times 10^4 \, \text{N/m}, \quad \mu = (0.4 \pm 0.8) \, \text{m}^2, \quad a = (0.06 \pm 0.1) \times 10^{-3} \, \text{m} \]

Based on the studies, graphs of the relative oscillation period of the column were constructed depending on the maximum oscillation amplitude. According to the analysis of the graphs (figure 2a), when the amplitude of the column vibration is \( 0.25 \times 10^{-3} \, \text{m} \), its relative oscillation period is 1.9. The mass of the column was 0.81 kg. If the mass of the column is 1.1 kg and the amplitude is \( 0.5 \times 10^{-3} \, \text{m} \), the relative oscillation period of the column is 1.49.

It should be noted that the amplitude of vibration of the column is directly related to the strength characteristic of the flexible base. This in turn causes the vibration frequency to change. Increasing the frequency of vibration allows you to intensify the process of ginning.

In Figure 3b, the graphs of the change in the relative oscillation frequency of the column are shown in relation to the nonlinear strength characteristic of the base.

The analysis of the obtained graphs showed that the ratio of the specific oscillations of the column to the calculated value leads to a linear change in the coefficients of strength of the base. As the strength increases, the frequency of specific vibrations also increases.

\[ \rho_k = \frac{0.25a \sqrt{c_1 c_2 / \mu}}{\sqrt{m_k} (2\pi \alpha \sqrt{c_2 / \mu} + 1.85 \sqrt{c_1})}; \quad \rho_k = \frac{2\pi}{T} \]

(3)

**Figure 3.** a) Is the graph of the dependence of the relative oscillation frequency of the column on the nonlinear characteristic of the base. b) Is the graph of the dependence of the relative oscillation period of the column on the maximum amplitude value.

When the coefficient of strength \( C_2 = 0.5 \times 10^4 \, \text{N/m} \) does not change, when the change of \( C_1 \) varies in the range \( (2.0 \pm 4.5) \times 10^4 \, \text{N/m} \), the relative oscillation frequency of the column increases almost twice, i.e. from 2.2.
If $C_2$ is increased by $1.2 \cdot 10^4 \text{ N/m}$, the increase in the specific vibration frequency of the column slows down (figure 3 b, curve 2). Hence, in order for the frequency of the vibration of the column to increase, it is necessary to increase its thickness, that is, the thickness of the base.

2. Conclusion

In sawdust, a columnar construction that intensifies the process of fiber separation from the seed was recommended. Kolosnik oscillations were seen through theoretical research, graphs of connection parameters were constructed, and optimal values were recommended based on their analysis.

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