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Analysis of Small Fluctuations of a Multifaceted Mesh under the Influence of Technological Load from the Cleaned Cotton - Raw

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ABSTRACT: The article presents the results of theoretical studies to determine the patterns of movement of cotton fly on a flat surface of the grid. A structural scheme and the principle of operation of the multifaceted mesh surface of a cleaner of fibrous material from fine waste is given. Analytical methods have obtained expressions for determining the movement of fibrous material on a mesh surface. By numerically solving the problem of the impact interaction of a fibrous material with a multifaceted grid, graphical dependences of the parameters of the fiber treatment zone are constructed.

KEY WORDS: Cotton, Small Waste, Cleaning, Multifaceted Grid, Elastic Support, Amplitude, Moment Of Inertia

I.INTRODUCTION

On a global scale, due to the large volume of clogged cotton, especially cotton-harvested, while improving the technique of primary processing of cotton, the development of theoretical foundations for cleaning cotton from small and large waste, substantiation of motion parameters, as well as operating modes of working bodies and mechanisms, due to they are conducting advanced theoretical and comprehensive experimental studies to determine the optimal values of geometric and kinematic sizes, providing loosening and cotton cleaning.

At the same time, ensuring the efficiency of cotton cleaning and preserving the preliminary quality indicators of cotton, including the creation of mathematical models that allow the selection of optimal cleaning modes from fine waste that do not negatively affect the quality of cotton and based on their decisions, determine the recommended parameters, reduce strong blows when loosening and cleaning of waste, the development of soft regime technologies, the creation of designs of resource-saving working bodies are especially important [1-4].

II. THEORETICAL RESEARCH

Recommended technology for cleaning cotton from fine waste includes pulling with bunches of flies, raw cotton on a multifaceted mesh surface. A feature of this technology is the small fluctuations of the multifaceted mesh due to the installation of the mesh in elastic (rubber) supports.

The calculation scheme for calculating small vibrations of a multifaceted grid is shown in Fig. 1. According to the design scheme, the grid of the cleaner was taken for a beam fixed by one ring to the body by a hinge and the other end is installed by means of an elastic support. Moreover, for the generalized coordinate of the oscillatory system, we take the angle of deviation of the grid φ_c . Then the kinetic energy of the polyhedral mesh of the cotton cleaner from fine waste will be [5]:

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$$T = \frac{J_c \dot{\varphi}_c^2}{2} = \frac{1}{2}\left(\frac{m_1 l^2}{3}\right)\dot{\varphi}_c^2 \quad (1)$$

Where, J_c - grid moment of inertia, m_1 - grid mass, l - grid length, $\dot{\varphi}_c$ - angular velocity of the grid.

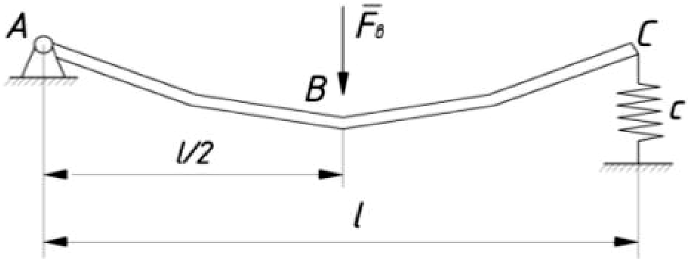

Fig. 1. The design scheme of the polyhedral mesh cleaner

The potential energy of the system will be:

$$\Pi = \frac{1}{2} c l^2 \varphi_c^2 \quad (2)$$

where, c - stiffness coefficient elastic supports, φ_c - grid angular movement.

In this case $p_C = \sqrt{\frac{c}{2m_1}}$, , having denoted, we obtain the law of small angular vibrations of a multifaceted grid in the form:

$$\varphi = A_\varphi \sin(p_c t + \beta) \quad (3)$$

Where, t - time, β - multifaceted grid initial phase, A_φ - amplitude of small vibrations of a multifaceted grid.

From expression (3), taking the derivative with respect to the expression, we obtain $\dot{\varphi}_c = A_\varphi p \cos(p\ t + \beta)$ (4)

Given the initial conditions:

$$o = A_\varphi \sin\beta;\ \dot{\varphi}_c = \omega_c \cos\beta \quad (5)$$

In this case, we obtain the law of small vibrations of a multifaceted grid:

$$\varphi_c = \frac{A}{p}\sin(p\ t + \beta) \quad (6)$$

Where, $A = \dfrac{1}{J_c\sqrt{2(1-\cos pt)}}$; $\beta = arctg\dfrac{\sin pt}{1-\cos pt}$;

In the calculations, we accept the following parameter values $F_в = 123{,}8\ N$ $J_в = (1{,}042 \div 1{,}5)\ kgms^2$; $c = 1{,}4\cdot 10^4\ Nm/rad$.

Based on the numerical solution of the problem, graphical dependences of the parameters of a polyhedral mesh on elastic supports are obtained. In this case, it is important to determine the angular displacements of a multifaceted grid. Since at large values of the span, the gap between the pegs and the net can increase, which can lead to inhibition of the movement of cotton, a decrease in the cleaning effect, and a decrease in the productivity of the cleaning section of the unit.

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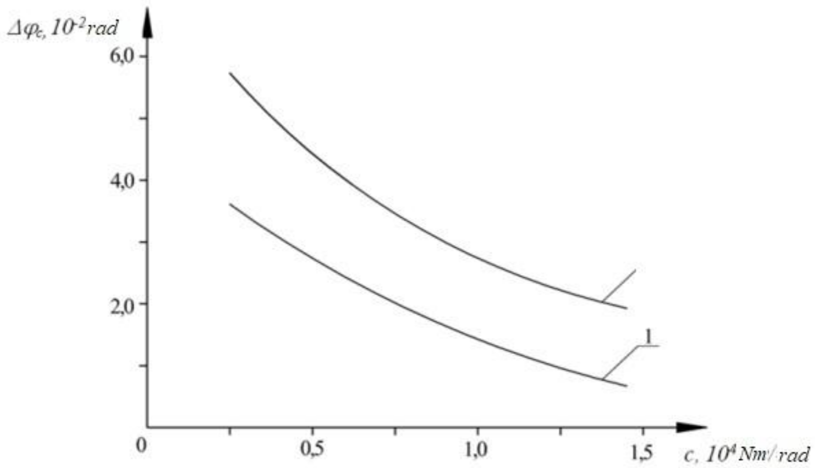
Graphical analysis

In fig. Figure 2 shows the graphical dependence of the variation in the range of oscillations of a multifaceted grid on the increase in the circular stiffness of the elastic support. An analysis of the constructed graphs shows that an increase in the circular stiffness of the elastic support of the multifaceted mesh in the range of $(0.25 \div 1.45) \cdot 10^4$ Nm / rad leads to a decrease in the nonlinear regularity of the magnitude of the amplitude of the oscillations of the grid from $0.68 \cdot 10^{-2}$ rad to $3,68 \cdot 10^{-2}$ rad with a net weight of 14.5 kg.

With a mass of 10.0 kg with increasing circular stiffness of the support, it leads to a decrease $\Delta\varphi_c$ from $5.81 \cdot 10^{-2}$ rad to $1.93 \cdot 10^{-2}$ rad. In order to ensure the necessary permissible values of the technological gap between the pegs and the mesh no more than $(18.0 \div 20.0) \cdot 10^{-3}$ m, you should choose values $\Delta\varphi_c$ in the range $(3.8 \div 5.6) \cdot 10^{-2}$ rad. Recommended values of the coefficient of circular stiffness of the elastic support of a multifaceted grid are $(0.42 \div 1.05) \cdot 10^4$ Nm / rad.



Where, 1 - with m_1 = 14.5 kg; 2 - with m_1 = 10 kg

Fig. 2. Graphic dependences of the change in the range of oscillations of a multifaceted grid on the increase in the circular stiffness of the elastic support

It is known that the greater the moment of inertia of a multifaceted grid, the more complicated the vibrations of a multifaceted grid with the required amplitude and frequency. It is important to reduce the mass of the grid. In fig. Figure 3 shows the graphical dependences of the variation in the range of oscillations of a multifaceted grid on the increase in the moment of inertia.

Analysis of the graphs shows that an increase in the moment of inertia of a multifaceted mesh from 0.25 kgm^2 to 1.35 kgm^2, the amplitude of the oscillations of the mesh decreases from $4.72 \cdot 10^{-2}$ rad to $2.94 \cdot 10^{-2}$ rad when the coefficient of circular stiffness of the elastic support is $0, 55 \cdot 10^4$ Nm / rad. As the value increases from to $1.45 \cdot 10^4$ Nm / rad, the range of angular oscillations of the multifaceted mesh decreases from $2.47 \cdot 10^{-2}$ rad to $1.78 \cdot 10^{-2}$ rad. To ensure the required values $\Delta\varphi_c = (3,8 \div 5,6) \cdot 10^{-2}\ rad$, the recommended values of the moment of inertia of the multifaceted grid are $(0.21 \div 0.65)$ kgm^2. In this case, the mass of the multifaceted mesh must be selected no more than $(7.5 \div 9.5)$ kg.

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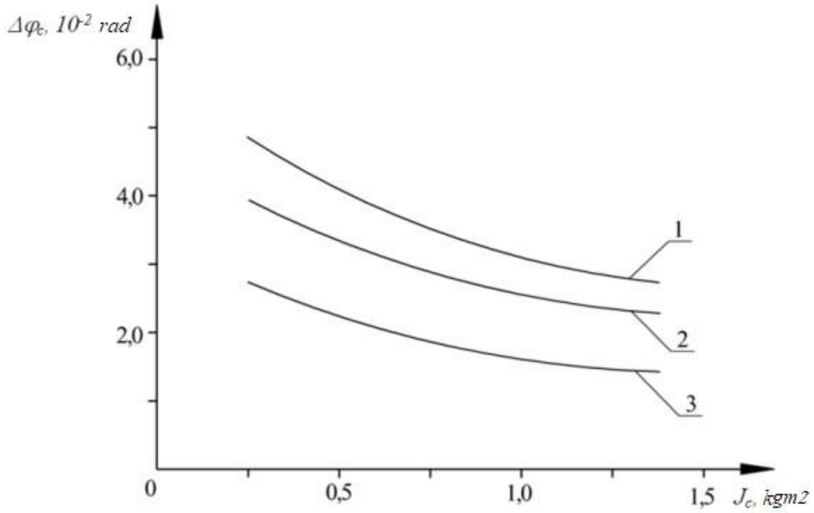

where, 1 - with c = $0.55 \cdot 10^4$Nm / rad; 2 - at c = $1.05 \cdot 10^4$ Nm / rad; 3 - at c = $1.45 \cdot 10^4$ Nm / rad

Fig. 3. Graphical dependences of the variation in the range of oscillations of a multifaceted grid from an increase in the moment of inertia

III. CONCLUSION AND FUTURE WORK

The small vibrations of a multifaceted mesh under the influence of the technological load from the cotton being cleaned were studied. Graphical dependencies of the variation in the range of oscillations of a multifaceted grid from an increase in the circular stiffness of the elastic support and from the moment of inertia of the grid are constructed to provide the necessary values $\Delta\varphi_c = (3{,}8 \div 5{,}6)\cdot 10^{-2}\ rad$ recommended values of the moment of inertia of a multifaceted grid are (0.21 ÷ 0.65) kgm^2.

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