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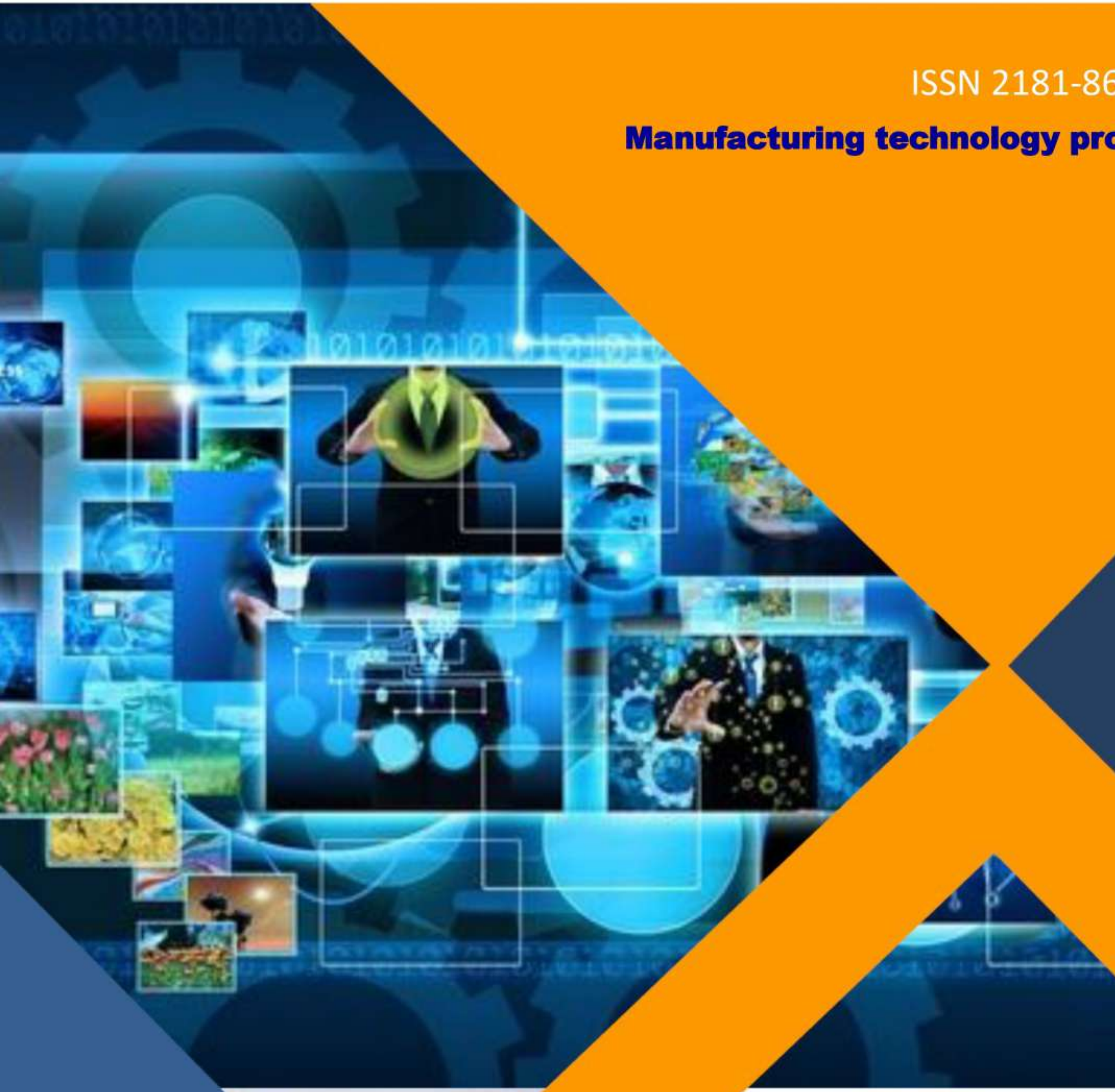
Manufacturing technology problems



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THE SCIENTIFIC BASIS OF THE LIGHTENED SHAFT

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Abstract: In the global development trend, special attention is being paid to the creation of a simplified new construction of the working bodies of technological machines, the development of structural, kinematic and dynamic analysis methods to justify their parameters, and the creation of techniques and technologies that ensure the quality performance of machine-building production processes, and the creation of their scientific basis. on a large scale, scientific and research work is being carried out.

In this direction, in particular, to reduce bending, tension, vibration in the shafts, including the creation of lightweight, resource-efficient constructions used in various technological machines of the primary cotton processing industry, to conduct targeted scientific research on the development of calculation methods and substantiation of their technological work process. is relevant

Keywords: gin, cylinder gourds, saw cylinder, shaft, raw roller, deflection, weight reduction, grooves, design features, bending stiffness.

Introduction. After the cotton is dried and cleaned in the cotton ginning plant, it comes to the main building, where the process of separating the fiber from the seed is carried out in ginning machines. The seeds from the gin machine are sent to processes such as lintering and delintering, and fiber products such as lint and wool are produced from them.

Ginning process (separation of cotton fiber from seed) considered the most responsible during the initial processing of cotton is carried out in sawing machines.

Circular saws are considered the main working organ of the gin, and their teeth pass between the colosniks and separate the fiber from the seed.

The main working parts of sawing machines are a sawing cylinder and a rib cage. As a result of the interaction of these two working bodies with each other, the processes of the machine work are carried out. The saw cylinder shaft is important in the grinding process. The research focuses mainly on improving resource efficiency by reducing the mass of the saw cylinder shaft, reducing energy consumption and bending, increasing machine productivity and ensuring product quality. [1, 2, 3].

Technological machine shafts are usually in the form of straight, sometimes straight, stepped, flexible, broken-line shafts with a circular cross-section, supported by bearings, on two or more special supports.

The most commonly used are straight shafts. They are mostly straight steps. The shafts are hollowed out for other details to pass through or to reduce the weight of the shafts, i.e. to lighten them. Usually, the end of the shaft is splined and serves to connect the coupling. Also, crankshafts are used in piston machines.

The shafts are used to mount gears, pulleys, saw cylinders and similar rotating parts.

The function of the shafts is to ensure the rotation of the parts in it, as well as to transmit the torque. In rotational motion, power is the product of torque times angular velocity $M{\cdot}\omega$ as it is measured by, the shafts definitely rotate in the working state, and depending on the location of the parts installed on them, the torque affects their entire length or in one section. In this case, the shaft is affected not only by the bending moment, but also by the twisting moment.

What factor should be used to determine the performance of a detail depends on the working conditions of this detail. For shafts, uniformity is strength and resistance to vibration. The indicators determining the strength of the shafts are evaluated by the property of being able to work without breaking and flawlessly, while being deformed under working conditions. Under the influence of a certain force and torque, a rotating shaft can bend beyond the permissible limit, despite being strong. Such a shaft should not be used, because the distance between the parts installed on the shaft is limited. Shaft bending beyond the permissible limit causes these parts to fail earlier than intended. Therefore, in addition to the strength of the shafts, it is necessary to ensure their integrity. For this, the value of the deformation is determined and compared with the permissible value in the section of the shaft where it can bend more. If the value found as a result of the calculation is less than or equal to the permissible value, the integrity of the shaft is satisfactory. Also, in the technological processes, in particular, by compressing more than the permissible during the assembly process of the saws placed on the shaft and the gaskets between them in the primary cotton processing enterprises, the accuracy of the saw cylinder increases. Excessive wear of saw cylinders has a negative effect on their durability. At the same time, excessive vibration of the shafts has a negative effect on the operation of the machine and accelerates the failure of parts due to fatigue. In this regard, the phenomenon of resonance is especially dangerous. Usually, in order to ensure the vibration resistance of the shafts, it is necessary to eliminate the factors that cause the phenomenon of resonance. It is known from the researches that the phenomenon of resonance occurs when the specific vibration frequency generated in the shaft itself becomes the same as the forced vibration frequency caused by the external force. Therefore, it is necessary to calculate these two frequencies during the vibration of the shafts and ensure that they do not become equal to each other.

The production of shafts is not a very complicated process, that is, the technology of preparation does not require a lot of labor and resources. The shaft of any machine is one of the most important parts because it works with heavy loads and in most cases at high speeds. It is known from the researches that as the length of the shaft increases, its integrity decreases based on theoretical and practical experiments.

Usually, shafts are used to transmit rotational motion over long distances within the limit of their construction. In mechanical engineering, shafts are widely used in transport and agricultural machines, water vessels, metal cutting machines, various mechanisms of mining and textile machines, in particular, in cotton ginning enterprises, which mainly take into account the heavy-sized work process. shafts that require a lot of resources are used. Long-sized shafts include shafts whose length is ten times greater than their diameter. Rotating shafts are attached to the box parts of mechanisms through sliding or rolling bearings. is installed. In most cases, the working shafts of textile machines consist of simple and high-precision surfaces with a straight cylindrical axis of rotation, surfaces with a slot or key slot, grooved, flanged parts. In preparation, all these types of surfaces are embodied in lathe spindles.

Materials and methods. As we know, a saw gin cylinder consists of a toothed saw disk that enters the shaft groove, seals between the saws, washers, and a compression nut.

Disadvantages of this design: The large bending of the shaft, which leads to a change in the technological distance and gap between the saws, is the high power required due to the large mass of the saw cylinder, which leads to fiber and seed damage, as well as reduced productivity. The disadvantage of this design is the formation of high reaction forces on the bearing supports due to the cyclical variation of the mass of the saw cylinder, as well as the disproportion of the mass. The saw cylinderis shown in Fig. 1.

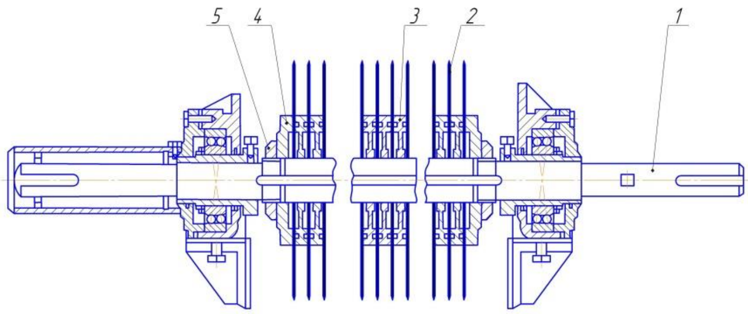


Fig. 1. Saw cylinder

It consists of saw shaft 1, saw discs 2, saw seals 4, washers 4, right and left clamping nuts 5. One end of the saw shaft is covered with a protective bushing, and the other is attached to the shaft of the armature by means of a half-bracket coupling. A functional washer is installed in the middle of the saw shaft

In the middle of the saw shaft, a functional washer is mounted on both sides of the saw blade.

A functional washer is mounted in the middle of the saw blade and saw blades are placed on both sides.

The diameter of the saw discs is 320 mm, the diameter between them is 162 mm, and calibrated seals are placed, which increase the rigidity of the saws and ensure their precise spacing.

The bending of the shaft should not exceed 0.3-0.4 mm and the side impact in rotation should not exceed 0.15 mm, otherwise the position of the saws in the space between the columns will change, which will lead to damage to the fibers attached to the disc teeth between the columns.

In the current design, the rotational speed of the saw shaft is 730 rpm.

Results and discussion. In view of the above, a new lightweight design of the saw gin cylinder has been developed to reduce the mass of the saw cylinder in the bending strength required by the proposed new design. It leads to further reduction of mass at the expense of the groove opened from the shaft, maintains the integrity of the shaft, saves resources, increases reliability and allows obtaining cotton fiber in the required quality. The inner part of the saw gin cylinder shaft ensures that the shaft bends within the allowable limit due to the execution of the groove, provides the required process of separating the fiber from the cotton, reduces the required power of the gin. (Fig. 2)

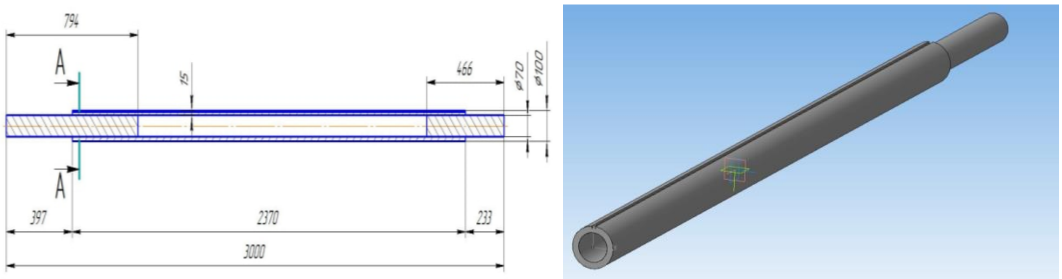


Fig. 2. New design of saw cylinder shaft

Saw groove cylinder performs the inner groove part of the shaft symmetrically threaded on the circular side and the input mass of the outer grooves entering the grooves in the corresponding inner grooves of the shaft leads to a specific equilibrium (no disproportion) with respect to the axis of rotationand leads to increased robustness and reliability in operation

Saw in theoretical researchlinterthe two-mass machine was considered as an aggregate (Figure 3). When solving the problem of the dynamics of the machine unit, the movement of the saw cylinder, the rotor of the electric drive was studied.

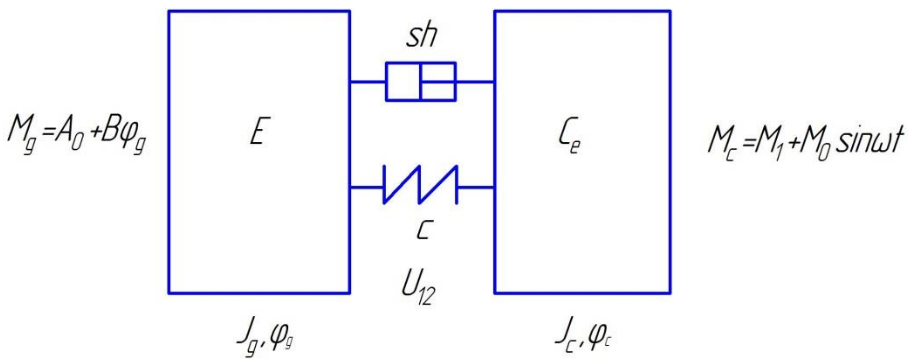


Figure 3. Calculation scheme of a two-mass machine unit

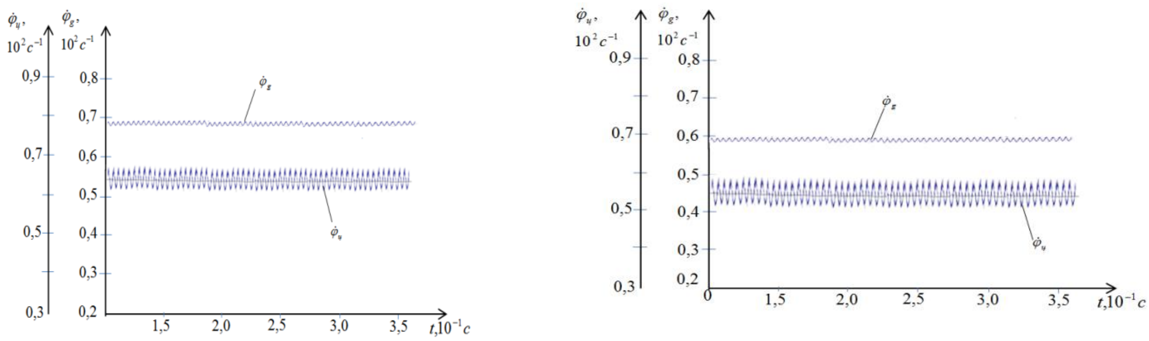
According to the calculation scheme presented in Figure 3, it is known that the rotor of the electric drive and the saw cylinder move in rotation, so 2 generalized coordinates can be defined.

As a result of the research, a system of differential equations representing the movement of the machine unit was created as follows [4].

$$J_g\ddot{\varphi}_g = A_0 + B\dot{\varphi}_g - c(\varphi_g - U_{12}\varphi_c) - b(\dot{\varphi}_g - U_{12}\dot{\varphi}_c);$$
$$J_c\ddot{\varphi}_c = U_{12}c(\varphi_g - U_{12}\varphi_c) + U_{12}b(\dot{\varphi}_g - U_{12}\dot{\varphi}_c) - M_c \pm \delta M_c, \quad (1)$$

where Jg, Jc, phg, $\dot{\varphi}_c$-moments of inertia and angular displacements of the engine and saw cylinder; b, c-coupling singularity and dissipative coefficients; A0,B-engine parameters; U12-transfer function. [5].

The MathCAD program was used to obtain the numerical solution of the differential equations (1) obtained as a result of the theoretical studies. Based on the numerical solution of differential equations obtained (1), laws of change of angular velocities of engine and lightened saw cylinder were obtained (Fig. 4).



a *b*

a-work productivity 3.5 t/h; b-work productivity 4.5 t/h

Figure 4. Laws of change of angular velocities of motor and lightened saw cylinder

The movements of the saw cylinder were analyzed in the research. The analysis showed that with the increase in productivity, the oscillation amplitude of the angular velocity of the saw cylinder also increases. This creates an angular acceleration. It is known thatangular acceleration causes additional impulsive forces to appear. Therefore, due to the generation of impulsive forces, the ability of the saw teeth to separate the fiber from the seed increases. But if the acceleration is too big, the fiber can be damaged [6].

The research also explored ways to ensure that the working processes of the saw cylinder are consistent (Figures 5 and 6). In theoretical studies, the performance of the saw cylinder was taken into account in the form of resistance moments, which are generated during the process of separating the fiber from seeded cotton.

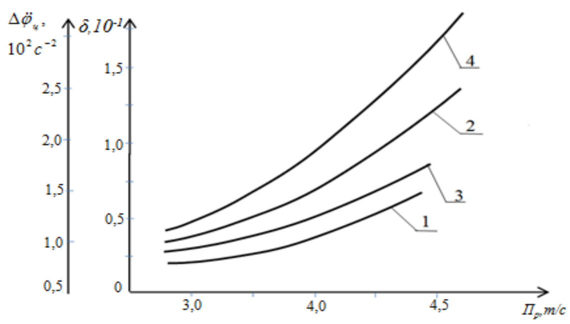


Fig. 5. Graphs of the dependence of the angular speed of the saw cylinder on the range of change and the unevenness coefficients of the angular speed on the performance

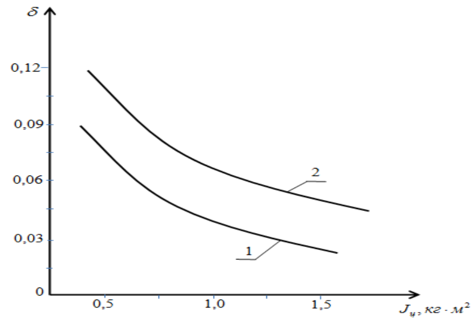


Fig. 6. Graphs of the dependence of the change of the roughness coefficient of the angular speed of the saw cylinder on the moment of inertia

As can be seen from the graphs in Fig. 5, the angular speed fluctuation increases with the increase of the work output, that is, the load, but with the increase of the moment of inertia, the unevenness coefficient of the angular speed of the saw cylinder decreases (Fig. 6).

Long, heavy and fast-rotating parts of technological machines require lightened shaft construction to reduce bending of the shafts, including saws.linterlinterwas developed for the cylinder, on the basis of which the technological gap between the saw cylinder and the fiber separation brush was sufficiently maintained, the fiber output increased, pollution and power consumption decreased[7,8].

A special experimental stand was prepared to measure the parameters determined to be studied in the experimental research. The electrotensometric scheme of the experimental stand is shown in Fig. 11 and it consists of: 1. asynchronous electric drive, 2. coupling, 3. 6. supports, 4. strain gauge, 5. saw cylinder shaft, 7. transformer, 8. "Arduino" ATsP microcontroller, 9-computer, 10-power source, 11-electronic barbell circuit.

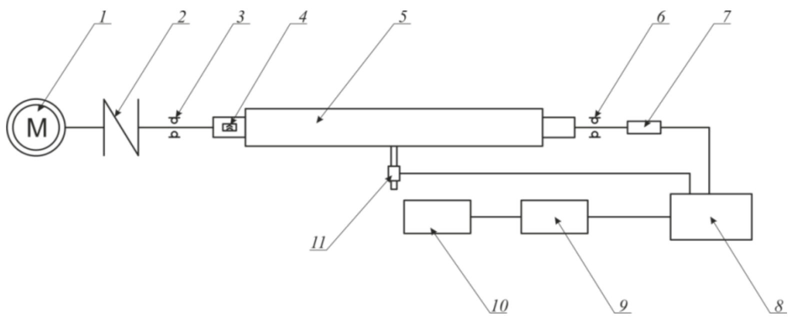
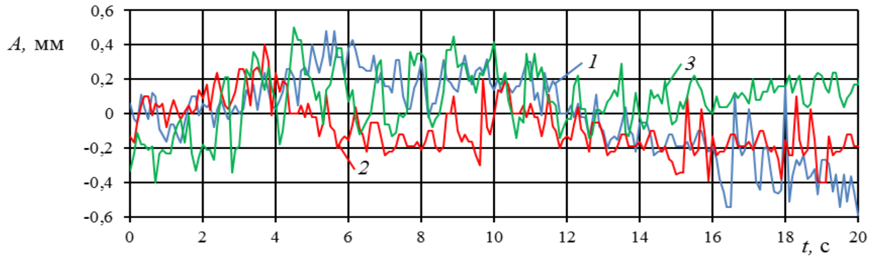
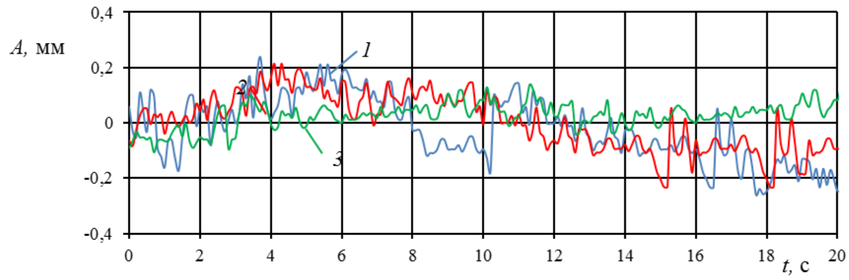


Figure 7. Electrotensometric scheme of the experimental stand

In the experiments, to determine the number of rotations on the shaft and the torque of the screwdriver, strain gauges were glued to the shafts in the bridge method, and the data were transferred to the "Arduino" ATsP microcontroller device through the transducer. An electronic barbell circuit was specially installed to determine the tilt of the shaft, and the data was transferred to the computer using an "Arduino" ATsP microcontroller.



a



b

1st work productivity 3.5 t/s; 2nd work productivity 4.0 t/s; 3rd work productivity is 4.5 t/s a-existing shaft; b-shaft in open position

Figure 8. Val'soscillograms reflecting their oscillations

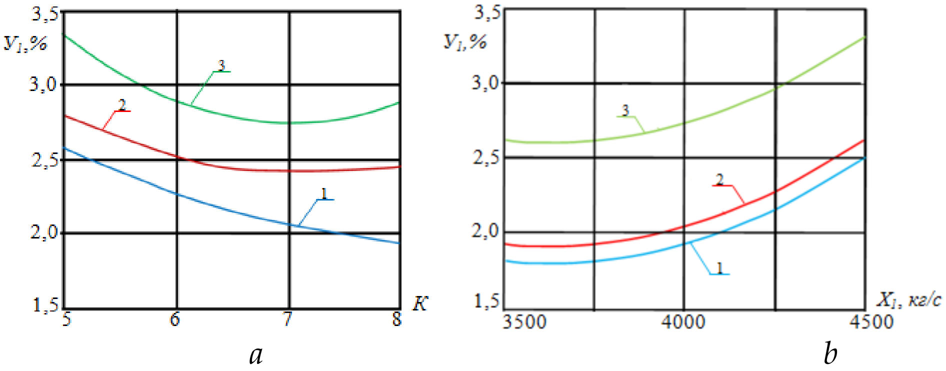
Based on the analysis of the oscillograms, it can be said that the range of vibration in the bending of the existing saw cylinder shaft exceeds 0.9 mm, in the proposed saw cylinder this range is reduced to (1.5-2.0) times.

The data obtained in the experiments were processed by the "regression analysis" program. Cochran's criterion was used to assess the homogeneity of variance, Student's criterion was used to assess the value of regression coefficients, and Fisher's criterion was used to assess the adequacy of regression models. The sum of impurities in fiber ($У_1$) and fiber output ($У_2$) were taken as output factors. The influence of incoming factors on outgoing factors was studied on the basis of repeated experiments. For this, a planning matrix is created. In each condition, the experiments are repeated 3 times. The number of incoming factors is 3tathe total number of experiments was n=8, the number of repetitions was m=3, and the total number of experiments was 24. The experimental results and variances of the outgoing factor were recorded in the form of a table.

$$Y_1 = 3{,}14 + 0{,}421X_1 - 0{,}671X_2 + 0{,}543X_3 + 0{,}362X_1^2 + 0{,}293X_1X_2 +$$
$$+ 0{,}31X_2^2 - 0{,}291X_2X_3 + 0{,}531X_3^2 \quad (1)$$

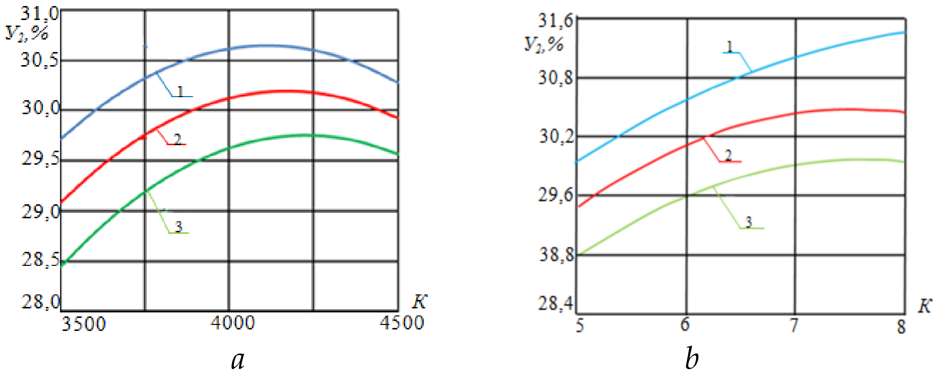
$$Y_2 = 34{,}323 + 0{,}419X_1 + 0{,}92X_2 - 0{,}512X_3 - 0{,}291X_1^2 + 0{,}334X_1X_2 -$$
$$- 0{,}446X_1X_3 - 0{,}229X_2^2 \quad (2)$$

(1) and (2) correlation graphs were obtained based on the numerical solutions of the regression equations (Figures 9 and 10).



1st cotton moisture 8.5%; 2nd cotton moisture 9.5%; 3-cotton moisture content 10.5%

Figure 9. Graphs of the dependence of the amount of waste on the inner diameter of the saw cylinder (a) and the productivity (b)



1st cotton moisture 8.5%; 2nd cotton moisture 9.5%; 3-cotton moisture content 10.5%

Figure 10. Graphs of dependence of fiber output on saw cylinder inner diameter (a) and productivity (b).

Conclusion. Technological machines are designed for a simplified shaft design, including a saw gin cylinder, to reduce the bending of the shafts of long, heavy and fast rotating bodies, based on which increased fiber output, pollution and power consumption due to adequate maintenance of the technological gap between the saw cylinder and fiber separation beam.

Long, heavy and fast-rotating bodies of technological machines use lightened shaft construction to reduce shaft bending, including saws.linterwas developed for the cylinder, on the basis of which the technological gap between the saw cylinder and the fiber separating brush was maintained enough, the fiber output increased, pollution and power consumption decreased. Has a lightweight saw cylinderlinterAccording to the results of the production test of the structure, due to the reduction of the bending of the saw cylinder, the fiber output will increase by 0.25-0.30%, the amount of impurities in the fiber will be up to 0.45% compared to the existing structure, the power consumption will decrease by 15-18%, the resource will be 1.5 times increase was found.

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C O N T E N T S

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY