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DYNAMIC STUDY OF THE STABILITY OF THE SHELL OF A COMPOSITE FEED CYLINDER DURING TORSION IN THE FEED ZONES OF ROTOR SPINNING MACHINES.

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ABSTRAKT. The article presents the results of theoretical research by determining the force of friction between the fibrous tape and the constituent feeding cylinder. The recommended formula for calculating the force of friction between the cylinder and the fibrous fiber. Based on the analysis of the constructed graphical dependencies, the values of the reduced mass were substantiated, stiffness coefficient, and geometric and kinematic parameters of the constituent supply cylinder of the discretizing zone in the spinning machine.

Keywords. Discretization of fibers, supply cylinder, shock absorber, friction, mass, stiffness, radius, angular velocity, damage, discretization.

Introduction. The essence of the discretization process of conclusions is in separating the tape into separate non-contacting fibers, in relative displacement, and in distributing them over a very large length.

In the process discretization takes place extra high thinning, the tape is drowning by 3000-7500 times, and in the section of a discrete flow with an ideal separation, there are 2-6 non-contacting fibers. This is the difference between discretization and pulling in [1].

In the spinning device, the main phases include: feeding, discretizing, conveying, picking up, and conveying with air. In the feed area, the tape is chosen from the pelvis and served at a constant speed. When sampling the tape from the canvas or pelvis doesn’t occur large axial force, and no deformation is observed in the tape, therefore doesn’t take place redistribution of fiber in the tape by length. During feeding, the cross section of the tape changes to a flat rectangular one, convenient for discretization. The tape passes through a sealing funnel which guides it to approximately the center of the width of the feeding cylinder. Sealing funnel has in impact primarily as an organ, giving certain direction for tape, and limiting its weight. The sealing funnel has an impact primarily as an organ, giving a certain direction for tape, and limiting its width. On machine BD – 200 section sealing funnel selected so that the width of the tape at the outlet does not exceed 9 mm and the thickness is 2 mm. Changing the section of the tape is achieved by increasing the density of the fibers in the section. The density of the fibers increases, since with a gradual decrease in the cross section for the passage of fibers in the tape, stresses arise under the influence of elastic transverse deformations. The sealing funnel does not change the uneven arrangement of fibers in the section of the tape. Voltage in the tape cause frictional forces on the walls of the sealing funnel, which prevent the movement of the outer layers of the fibers. These frictional forces operate around the perimeter sections sealing funnel uneven. These friction forces act unevenly along the perimeter of the section of the sealing funnel. To prevent a hidden draught, it is necessary to exist a section of the sealing funnel brings closer to

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the area of the compressing feeder device. The tape is compressed between the feed cylinder and the table. Wherein, the density of the fibers in the section increases, and at the same time increases the width of the tape to the width of the slot in the table [2].

In the known construction, the supply cylinder is corrugated with a straight corrugation (parallel to the axis of the cylinder).

During the operation of this cylinder, the condition for reliable operation of the fiber ribbon, without disturbing the uniformity of the tape, is to overcome the resistance of friction forces between the tape and the table, and development is necessary moving with supply cylinder.

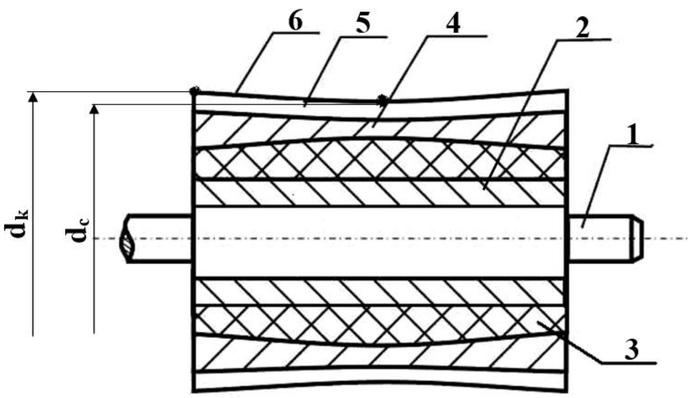
In a well-known design, the supply cylinder is made corrugated with straight corrugations (parallel to the axis of the cylinder). When this cylinder is operating, the condition for reliable operation of the fiber ribbon, without violating the uniformity of the tape, is to overcome the resistance of friction forces between the tape and the table and create the necessary movement using the supply cylinder. In this case, the force of friction changes with the force of clamping the tape to the table, and some sliding of the tape also occurs. This slip depends on the distance between the corrugated feeder cylinder of the supply cylinder.

The disadvantage of this design of the corrugated supply cylinder is the uneven distribution of the friction force along the length of the cylinder, which leads to some lag in the movement of the tape fibers along the edges of the cylinder. Due to the rigid interaction of the supply cylinder with the fibers, their damage occurs.

In another well-known design of the supply cylinder, the toothed garnitures are made obliquely to the axis of the cylinder and form single diamonds arranged in rows along the length of the supply cylinder. [3]

The disadvantage of the existing design is also the uneven distribution of the friction force of the fibers of the tape with a corrugated cylinder and a table along the length of the cylinder. This leads to some lag in the movement of the fibers of the tape along the edges of the cylinder. In addition, damage to the fibers of the tape occurs due to the rigid interaction of the rhombic corrugations on the tape, although there is a cushioning of the table due to the springs.

Recommended design scheme of the discretization zone supply the cylinder in a spinning machine. To ensure the uniformity of the tape feed along the length of the cylinder and reduce the damage to the fibers in the tape, the design of the cylinder was improved, allowing a uniform density of fibers in the tape along the length of the cylinder by creating a shear force of the fibers from the edges and in the middle of the tape [4].



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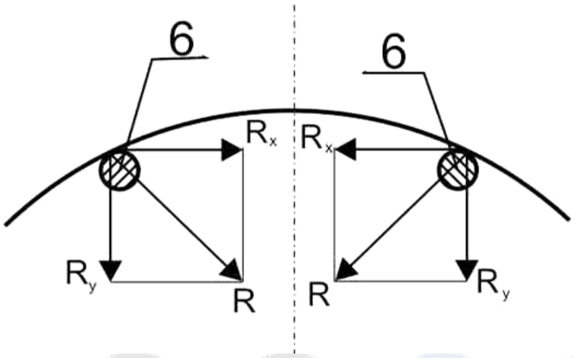

Figure 1. supply cylinder of the spinning device

The essence of the design lies in the fact that the supply cylinder is made composite of an outer corrugated bushing and an inner bushing connected to each other by means of a barrel-shaped rubber bushing along the outer surface, while the inner bushing is rigidly mounted on the belt drive, while the outer surface of the corrugated bushing is made curved, having a concave shape, the diameter in the middle of the sleeve of which is less than the diameters along the edges of the cylinder by 2.0 mm.

The design of the utility model is explained by the drawing, where in Fig. 1 is a general view of the supply cylinder in section.

The design of the supply cylinder of the spinning device consists of a drive shaft 1, mounted on it by means of keys (not shown in the figure) inner sleeve 2, an elastic rubber sleeve 3 of a barrel-shaped shape is mounted on it and a corrugated sleeve 4 with corrugations 5 put on it, having a concave curvilinear shape 6 on the outer surface. In this case, the diameter in the middle of the corrugated sleeve 4 is less than the diameters along the edges of the cylinder by 2.0 mm.

The process of feeding the tape into the sampling zone is carried out as follows. The fibrous mass (cotton fibers) in the form of a tape enters through the sealing funnel to the feed zone between the table (not shown in the figure) and the supply cylinder with a corrugated sleeve 4. In this case, the tape (fibrous mass) is compressed between the corrugated sleeve 4 and the table. Here, the pressure on the belt from the corrugated sleeve 4 of the supply cylinder is distributed more evenly along its length. This is ensured by deformation of the barrel-shaped elastic rubber sleeve 3. The greater the density of the fibers and its unevenness along the length of the tape cylinder, the greater the compression deformation of the elastic rubber sleeve 3. The barrel-shaped elastic rubber sleeve 3 centers the position of the corrugated sleeve 4 relative to the axis of rotation. In addition, the fibers located at the edges of the tape along the length of the supply cylinder due to the horizontal shear forces R_x that arise towards the middle of the tape will to some extent move towards the middle of the cylinder. Forces R_y take the fibers of the tape to the surface of the supply cylinder.

$$R = R_X + R_Y$$

here, R_X – the horizontal component of the reaction force R on the tape fiber, R_Y – the vertical component of the reaction force R on the tape fiber. This reduces the density of the fibers in the extreme positions of the moving tape. Thus, the uniformity of the density of the fibers across the width of the tape is ensured, and thus the uniformity of the feed of the tape, as well as the reduction of damage to the fibers.

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Determination of the force of rattling between the fibrous tape and the supply cylinder. During the operation, the content supply cylinder compresses the tape and pushes it into the sampling zone at the cross-sectional area of the appropriate shape (2x9) mm2. In the current design, this is mainly due to the coefficient of friction and compressive strength between the fibers and the cylinder [5]. The rubber bushing of the supply cylinder with the recommended composition also depends on the elasticity to a certain extent.

During the interaction of the fiber tape with the content supply cylinder, the following forces are generated: cylinder gravity, centrifugal force; rubber bushing elasticity, fibrous tape elasticity; friction force and reaction force.

The calculation scheme for the interaction of the fiber belt with the discrete zone supply cylinder is shown in Figure 2.

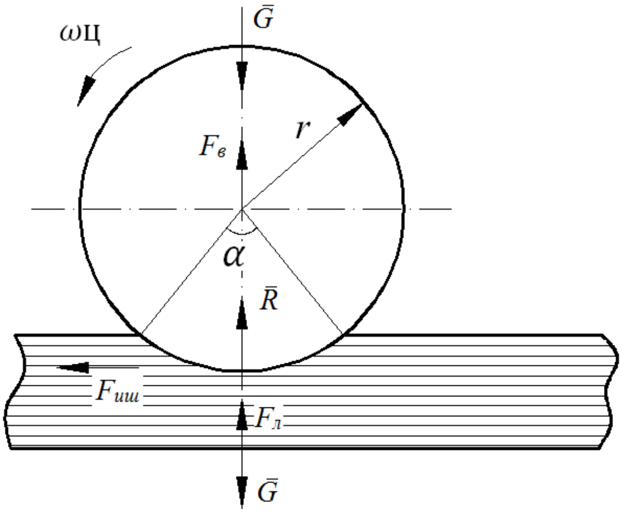

Figure 2. Interaction calculation scheme with composite cylinder and fiber tape

The mass of the supply cylinder is $m_в$, the mass of the flexible rubber bushing is $m\tau_в$ and the mass of the garniture is m_p. Therefore:

$$G_T=(m_в+m_{вт}+m_p)g \qquad (1)$$

here g – free fall acceleration.

Centrifugal force of the supply cylinder [6]:

$$F_{м.ц}=\left(\frac{\pi n_ц}{30}\right)^2\left(m_в+m_{вт}+m_p\right)r \qquad (2)$$

here, $n_ц$ – supply cylinder rotation frequency; $\pi=3.14$; r- cylindrical garniture tooth bevel radius.

It should be noted that the restorative force of the rubber bushing, as well as the restorative force in the vertical displacement of the fibrous tape, is also directed upwards, the values of which are taken into account by the following total elasticity [7]:

$$F_б=\frac{c_{вт}\cdot c_л r^2}{c_{вт}+c_л}\left(1-\cos\frac{\alpha}{2}\right) \qquad (3)$$

Frictional force accordingly [81]:

$$F_{иш}=fN \qquad (4)$$

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here, f – coefficient of friction; N – total power; a – the angle of coverage of the deformation zone of the tape.

The contact surface of the supply cylinder reflux garniture and the fiber tape is defined by the following expression [8]:

$$S_{\pi} = 2rl\sin\frac{\alpha}{2} \quad (5)$$

here, l – cylinder length.

Taking into account the above, the frictional force between the surface of the cylindrical garniture, which provides a discrete zone under the condition of balance of forces, was determined by the following expression [8]:

$$F_{иш} = \left\{ \left(m_{в} + m_{вп} + m_{2} \right) \left[\partial + \left(\frac{\Pi n_{ц}}{30} \right)^{2} r \right] + \frac{c_{вт} \cdot c_{лг}}{c_{вт} + c_{л}} \left(1 - \cos\frac{\alpha}{2} \right) \right\} \cdot f \quad (6)$$

In deriving the resulting expression, the motion is determined in steady state, i.e., for the calculation where the acceleration value is zero.

Analysis of the dependence of the friction force on the parameters of the supply cylinder. To determine their dependence on the parameters of the cylinder providing the friction force, their calculated values are taken into account in the following intervals:

$n_{ц} = (10 \div 20)$ rotation/min; $r = (9 \div 11) \cdot 10^{-3}$ м; $m_{в} = (100 \div 124) \cdot 10^{-3}$ *kg*;

$m_{вт} = (15 \div 25) \cdot 10^{-3}$ *kg*; $m_{2} = (30 \div 45) \cdot 10^{-3}$ *kg*; $\alpha = \left(8^{0} \div 16^{0} \right)$;

$c_{вт} = (15 \div 25)$ сН/мм; $c_{к} = (4.5 \div 7.0)$ сН/мм; $f = 0.2 \div 0.3$

As a result of solving the problem, a graph of the dependence of the movement of the friction force between the content supply cylinder of the sampling zone and the ribbon fiber was constructed. Figure 3 shows the graphs of the frictional force dependence of the total mass of the cylinder supplying the discrete zone with the toothed garniture and fiber tape.

It is known [9,10] that the higher the mass values, the higher the pressure force on the friction surfaces, i.e. the higher the friction force. According to the analysis of the graphs in Figure 3, U_{wr} $F_{иш}$ values increase linearly from 0.1·10 cH to 0.58·10 cH when the total mass of the composite cylinder increases from $0.75 \cdot 10^{-1}$ kg to $2.0 \cdot 10^{-1}$ kg and the coefficient of friction is at least 0.2. Correspondingly, when the coefficient of friction increases to 0.3, the values of U_{wr} $F_{иш}$ increase from 0.315·10 cH to 1.18·10 cH in a linear bond. In the sampling zone, sufficient frictional force is required to move the fiber tape to the workpiece at a specified speed without slipping. But on the other hand, it should be noted that as the pressure on the fiber tape increases, the damage to the fibers also increases.

Therefore, to ensure that the friction force is in the range (0,8÷1,1)·10 cH, the recommended values of the total mass of the supply cylinder (1,8÷2,5) $\cdot 10^{-1}$ kg, and f =0,2÷0,25

The friction force is largely directly related to the stiffness of the cylindrical rubber bushing and the value of the fiber belt deformation, ie the density. Figure 4 shows the graph of the dependence of the frictional force between the cylinder providing the sampling zone and the fiber belt on the cylinder rubber bushing and the coefficient of elasticity of the fiber tape.

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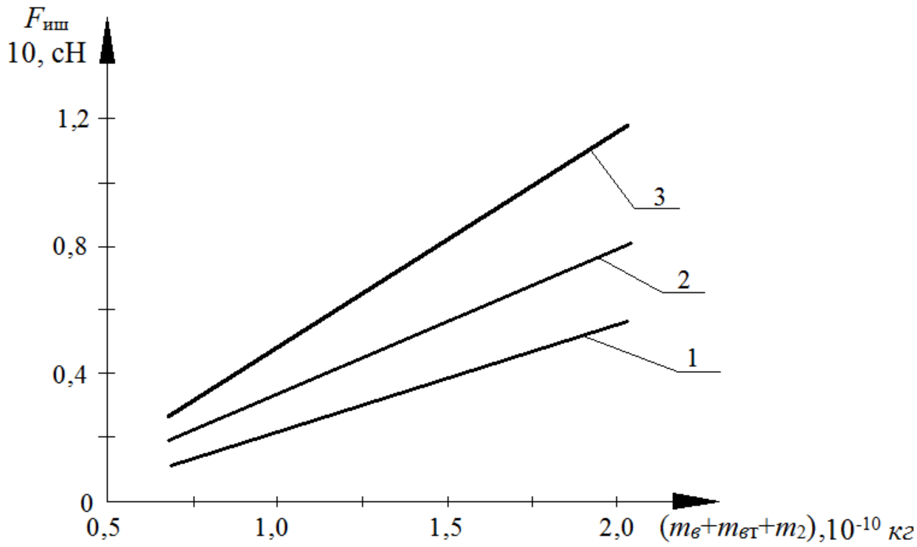
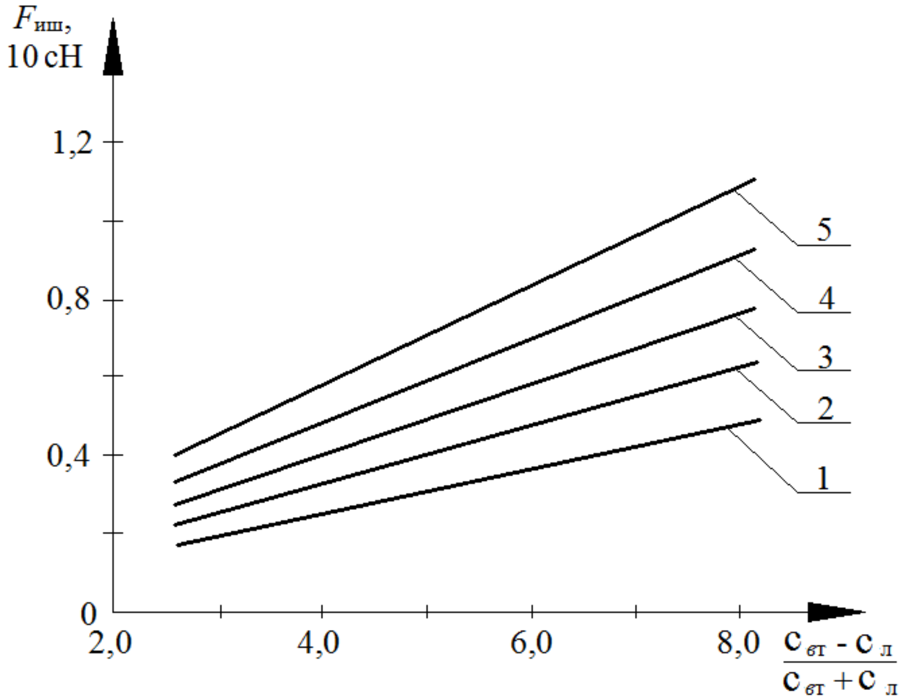


1-f=0,2; 2-f=0,25; 3-f=0,3

Figure 3. Graphs of the friction force dependence of the total mass of the cylinder supplying the composition of the proposed sampling zone with a toothed garniture and fiber tape



$1 - r = 8.5 \cdot 10^{-3}$ м; $2 - r = 9.0 \cdot 10^{-3}$ м; $3 - r = 9.5 \cdot 10^{-3}$ м;

$4 - r = 10 \cdot 10^{-3}$ м; $5 - r = 10.5 \cdot 10^{-3}$ м;

Figure 4. Graphs of the dependence of the friction force between the cylinder providing the sampling zone and the fiber belt on the coefficients of elasticity of the cylinder rubber bushing and the fiber tape

The analysis of the constructed graphs requires that the frictional force is 0, when the total buffer coefficient of 2,8 cH/мм is 8,0 cH/мм and the outer radius of the cylinder is r=8,5·10^{-3}m, 0,19·10 cH to 0,52·10 cH increases in a linear bond. Also, when the cylinder radius increases to r=10,5·10^{-3}m, the frictional force between the correspondingly provided cylindrical garniture and the fiber belt increases in a linear pattern from 0,45·10 cH to 1,12·10 cH. Therefore, in order to

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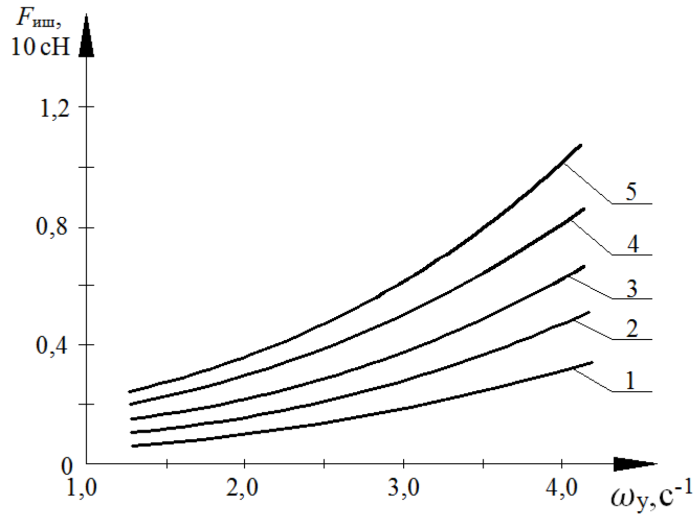
increase the frictional force between the supply cylinder and the fibrous tape, it is expedient to select their applied coefficients in the range (7,0 ÷ 9,0) cH/мм.



$1-\alpha=8^0$; $2-\alpha=10^0$; $3-\alpha=13^0$; $4-\alpha=14^0$; $5-\alpha=16^0$;

Figure 5. Graphs of the dependence of the frictional force between the cylinder providing the sampling zone and the fiber belt on the angular velocity of the cylinder

It is recommended that the radius of the supply cylinder gear be $r \le (9.5 \div 10.5) \cdot 10^{-3}$ m. The speed of supply of the sampling zone, i.e. the productivity, depends mainly on the angular velocity of the supply cylinder. The angular velocity indicates sufficient between the cylinder and the fibrous tape. Figure 5 shows graphs of the dependence of the friction force between the cylinder providing the sampling zone and the fibrous tape on the cylinder angular velocity. It can be seen that the U_{wr} $F_{иш}$ values increase in a nonlinear coupling from $0.08 \cdot 10$ cH to $0.36 \cdot 10$ cH when the angular velocity of the supply cylinder increases from $1.5 \cdot c^{-1}$ to $4.0 \cdot c^{-1}$ and the dip angle is $\alpha = 8^0$. It can be noted that if the angle of immersion of the cylinder in the differentiation in the tape increases to 16^0, the friction force increases in a nonlinear pattern from $0.28 \cdot 10$ cH to $1.09 \cdot 10$ cH (Fig. 5, Figures 1.5).

Hence, it is effective to increase the angular velocity of the cylinder to increase the frictional force between the cylindrical rifle garniture and the fiber tape in the discrete zone. Recommended values:

$$\omega_ц = (3{,}0 \div 3{,}5)c^{-1}; \quad \alpha = \left(12^0 \div 14^0\right)c^{-1}$$

Conclusion. A new effective design scheme of the composite supply cylinder of the discretization zone of the spinning machine is recommended. On the basis of theoretical studies, a formula was obtained for calculating the friction force between the supply cylinder and a fibrous tape, the main parameters of the cylinder were substantiated.

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