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DETERMINATION OF THE FRICTION FORCE BETWEEN THE COMPOSITE FEEDING CYLINDER AND THE FIBER ROVE

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Annotation. The article covers the process of pushing the rove by composite feeding cylinder in discretization cross-sectional surface in an appropriate form by squeezing, which, in the existing construction, mainly depends on the coefficient of friction between the fiber and the cylinder and the pressure force. Analytical solutions of depending of the newly designed, i.e., the composite feeding cylinder on the rigidity of the rubber bushing are given. In the process of impacting the fiber rove with the cylinder that provides the content, forces are generated, and the cylinder's gravity force, centrifugal force; rubber bush unit force, fiber plug unit force; friction force and reaction force were calculated.

Keywords: friction force, fiber rove, spinning machine, discretization, discretization drum, fiber, belt, feeding cylinder, rubber rigidity, speed, grip angle, hardness, deformation, force.

Introduction. Textile industry is one of the important strategic sectors of the republic. In order to realization the decrees and decisions of the President of Republic, technical re-equipment and modernization of textile enterprises for the production of high-quality spun yarn and textile products, i.e., innovative technological processes and production automation, are being implemented. In our country, it is planned to increase the export of light industrial products to 7 billion USD by 2025, and in 2019-2025, it is planned to increase the production volume by 3.8 times, ready-made textile products by 3 times, and knitted products by 3.1 times [1].

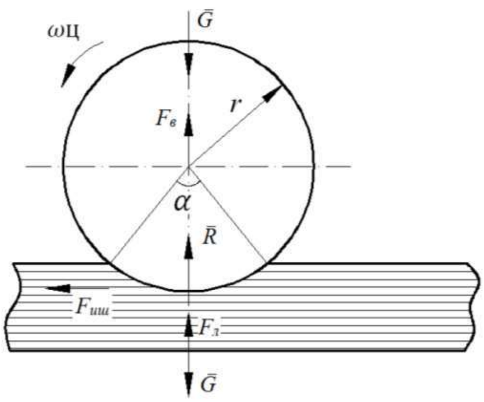


Fig. 1. Calculation scheme of impact of composite cylinder and fiber tape and the process of its application in practice

The composite feeding cylinder compresses the rove in the course of work and pushes it to the discretization zone in the space of the cross-sectional surface of the appropriate shape (2×9) mm^2. In the existing construction, it mainly depends on the friction coefficient between the fibers and the cylinder and the pressure force [2].

The recommended composition also depends on the rigidity of the rubber bushing of the supply cylinder. The following forces are generated during the interaction of the fiber coil with the cylinder providing the content: cylinder gravity, centrifugal force; rubber bush unit force, fiber plug unit force; friction force and reaction force.

The calculation scheme of the impact of the feeding cylinder and the fiber rove in discretizing zone and the process of its application in practice are shown in Fig. 1.

In this case, the mass of the feeding cylinder consists of the mass of the shaft $m_в$, the mass of the belt rubber bush $m\tau_в$ and the mass of the fittings m_p.

Therefore:

$$G_т = (m_в + m\tau_в + m_p)g \quad (1)$$

where g is the acceleration of free fall.

Centrifugal force of the feeding cylinder [3]:

$$F_{m\mu} = (\frac{\pi n_ц}{30})(m_в + m\tau_в + m_p) \cdot r \quad (2)$$

where, $n_ц$ is the rotation frequency of the feeding cylinder; π=3.14; r is the radius of the tooth of the cylinder head.

It should be noted that the restoring force of the rubber bushing, as well as the restoring force in the vertical displacement of the fiber rove, is directed upwards, the values of which are considered account by the following general unitary force [4]:

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

$$F_{иш} = fN \quad (4)$$

where, *f* is the coefficient of friction; *N* is total force; α is the coverage angle of the rove deformation zone.

The contact surface of the feeding cylinder with a corrugated fittings and the fiber rove is determined by the following expression [5]:

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

where *l* is the length of the cylinder.

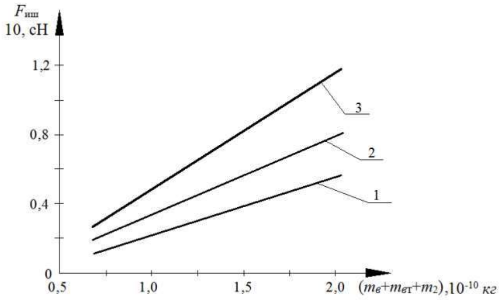
Considering the above, the force of friction between the surface of the discretizing zone providing the cylinder and the fiber rove was determined by the following expression [6]:

$$F_{иш} = \left\{(m_в + m_{вп} + m_2) \cdot \left[\partial + (\frac{\Pi n_ц}{30})^2 \cdot r\right] + \frac{c_{вт} \cdot c_л r^2}{c_{вт} + c_л} \cdot (1 - cos\frac{\alpha}{2})\right\} \cdot f \quad (6)$$

When deriving the resulting expression, the movement is determined in a stable mode, that is, for the calculation of the value of the acceleration equal to zero. In order to determine the dependence of the friction force on the parameters of the cylinder, their calculated values were considered in the following ranges:

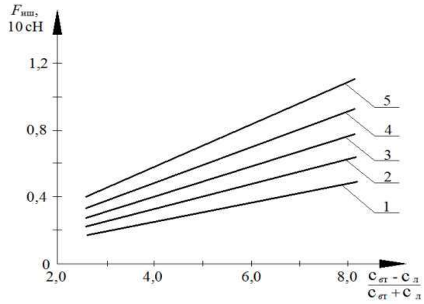
$n_ц$=(10÷20) rpm; r=(9÷11)·10^{-3} m; $m_в$=(100÷124)·10^{-3} kg; $m_{вт}$=(15÷25)·10^{-3} kg; m_2=(30÷45)·10^{-3} kg; α=(8°÷16°); $c_{вт}$=(15÷25)·sN/mm; $c_к$==(4,5÷7,0)·sN/mm; f=0,2÷0,3.

As a result of the solution of the problem, a graph of the dependence of the force of friction between the discretizing zone of composite feeding cylinder and the fiber rove was built. The graphs of the dependence of the total mass of the cylinder containing the contents of the proposed discretization zone on the friction force with the teeth fittings set and the fiber rove are shown in Fig. 2.



1-f=0.2; 2-f=0.25; 3-f=0.3

Fig. 2. Graphs of the dependence of the total mass of the cylinder containing the content of the recommended discretization zone on the friction force with the teeth fittings set and the fiber rove



1–r=8.5·10^{-3}m; 2–r=9.0·10^{-3}m; 3–r=9.5·10^{-3}м; 4–r=10.0·10^{-3}м; 5–r=10.5·10^{-3}м;

Fig. 3. Graphs of dependence of the friction force between the discretizing zone between the cylinder and the fiber rove on the coefficients of uniformity of the cylinder rubber bushing and the fiber rove

As we know [7], as the mass values increase, the pressure force on the friction surfaces increases, that is, the friction force increases. Based on the analysis of the graphs in Fig. 3, when the total mass of the contained cylinder increases from 0.75·10^{-1} *kg* to 2.0·10^{-1} *kg* and the coefficient of friction is at a minimum value of 0.2, the $F_{иш}$ values range increases linearly from 0.1·10 *sN* to 0.58·10 *sN*. Correspondingly, when the friction coefficient increases to 0.3, the values of $F_{иш}$ increase from 0.315·10 *sN* to 1.18·10 *sN* in the linear bond.

In the discretization zone, sufficient friction force is required to move the fiber coil to the workpiece at a specified speed without slipping.

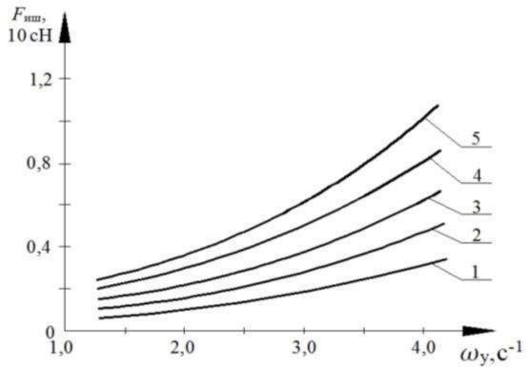
But on the other hand, it should be noted that as the pressure on the fiber pile increases, the damage to the fibers also increases. Therefore, in order to ensure that the friction force is in the range of (0.8÷1.1)·10 *sN,* recommended values for the total mass of the composite feeding cylinder in the range of (1.8÷2.5) ·10^{-1} *kg*, and *f* =0,2÷0,25.

The friction force is directly dependent on the quality of the rubber bushing of the supplying cylinder and the value of the deformation of the fiber, that is, its density. Fig. 3 shows the graphs of dependence of the friction force between the cylinder feeding the discretization zone and the fiber rove on the coefficients of uniformity of the rubber bushing of the cylinder and the fiber rove. The analysis of the constructed graphs requires that when the total coefficient of friction is from 8.0 *sN/mm* to 2.8 *sN/mm* and the outer radius of the cylinder is *r*=8.5·10^{-3} *m,* the frictional force increases from 0.19·10 *sN* to 0.52·10 *sN* in a linear bond [8].

Moreover, when the radius of the cylinder increases to *r*=10.5·10^{-3} *m*, the friction force between the corrugated gasket of the corresponding feeding cylinder and the fiber rove increases linearly from 0.45·10 *sN* to 1.12·10 *sN*. Therefore, in order to increase the friction force between the feeding cylinder and the fiber rove, it is appropriate to choose their coefficients of uniformity in the range of (7.0÷9.0) *sN/mm*.

In this case, it is recommended that the gear radius of the feeding cylinder is *r*≤(9.5÷10.5)·10^{-3} *m*. Discretization zone feeding speed, that is, productivity depends mainly on the angular speed of the feeding cylinder. The angular speed shows a sufficient distance between the cylinder and the fiber rove. Discretization zone feeding speed, that is, productivity depends mainly on the angular speed of the feeding cylinder. Angular speed shows enough between the cylinder and the fiber coil [9, 10].

It can be seen from the graphs of the dependence of the friction force between the friction force between the discretizing zone of the feeding cylinder and the fiber rove on the angular speed of the cylinder that when the angular speed of the cylinder increases from 1.5 s^{-1} to 4.0 s^{-1} and the dip angle is α=8, the values of F_{uw} increase from 0.08·10 *sN* to 0.36·10 *sN* in nonlinear bond. It can be noted that when the angle of immersion of the differentiating cylinder into the pile increases to 16˚, the friction force increases from 0.28·10 *sN* to 1.09·10 *sN* in a nonlinear bond (Fig. 4, graphs 1-5).



1-α=8˚; 2-α=10˚; 3-α=13˚; 4-α=14˚; 1-α=16˚

Fig. 4. discretizing zone of the feeding cylinder and the fiber rove on the angular speed of the cylinder

Therefore, it is effective to increase the angular speed of the cylinder in order to increase the friction force between the corrugated fittings of the composite feeding cylinder and the fiber rove in the discretization zone. Recommended values are ω_{u}=(3÷3.5)s^{-1}; α=(12˚÷14˚)

Conclusion.

1. Mathematical expression representing the vertical oscillations of the discretizing feeding drum taking into account the rigidity of the belt shock absorber has been obtained. The formula for determining the friction force between the discretizing cylinder and the fiber rove has been recommended.

2. Graphs of dependence of the total mass of the composite feeding cylinder of the recommended discretization zone on the friction force with the teeth fittings and the fiber rove have been constructed. In order to ensure the friction force is in the range of (0.8÷1.1)·10 *sN,* the recommended values of the total mass of the composite feeding cylinder are (1.8÷2.5)·10^{-1} *kg*, and f=0.2÷0.25.

3. Graphs of dependence of the friction force between the discretizing zone between the feeding cylinder and the fiber rove on the coefficients of uniformity of the rubber bushing of the cylinder and the fiber coil show that in order to increase the friction force between the feeding cylinder and the fiber rove, it is advisable to choose their coefficients of uniformity in the range of (7.0÷9.0) *sN/mm.* In this case, it is recommended that the outer radius of the supply cylinder be *r*≤(9.5÷10.5)·10^{-3} *m*.

The graphs of the dependence of the friction force between the cylinder and the fiber rove, which provides the discretizing zone, on the angular speed of the cylinder have been determined. It is considered effective to increase the angular speed of the cylinder in order to increase the friction force between the corrugated fittings of the composite feeding cylinder and the fiber rove in the discretizing zone, where

$\omega_ц$=(3÷3.5) s^{-1}; α=(12˚÷14˚) values have been recommended.

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FORECASTING THE PROSPECTIVE VOLUME OF CARGO TRANSPORTATION FOR THE DEVELOPMENT OF THE TRANSPORT NETWORK

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Abstract:

Objective. The content of the article is mainly concerned with solving the problem of efficient distribution of cargo flows in the transport network and their optimal development in accordance with the growth (dynamics) of traffic volumes, taking into account the throughput of the road. For this, methods for generating initial data and determining their reliability are presented. As an example, predictive calculations

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