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STUDY OF THE PROCESS OF AUGER CLEANING OF COTTON CHEESE TO ELIMINATE

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Abstract: *The article presents the results of studies of the movement of raw cotton in a screw cleaner. Considering that when the mass of raw cotton is moving along the trough along the plane with a uniform speed, the equilibrium condition must be met, equilibrium equations are drawn up and mathematical expressions are obtained allowing to calculate the moment of rotation on the shaft of the screw cleaner and the power consumption when processing raw cotton. The problems of increasing the cleaning effect of a screw cleaner with a decrease in defect formation are considered. Mathematical models are obtained that allow to determine the angle at which a raw cotton particle will be held by a pin, when moving relative to the mesh surface. Experimental studies have shown that the most effective retention of raw cotton is observed at a pin engagement angle of 600.*

Keywords: *Cotton raw, torque, power consumption, friction, equilibrium condition, screw cleaner, filling factor purifier, cleansing effect, peg malformation, gripping ability, gripping angle.*

INTRODUCTION

The constant increase in the textile industry's requirements for the quality of cotton fiber being processed, is forcing the cotton-cleaning industry to seek out all the new reserves in technology and the technique of cotton preprocessing in order to produce fiber that meets the requirements of the relevant standards. In drum cleaners, when pulling raw cotton over a mesh surface, the friction forces of the bat against the mesh surface and airflow resistance on the one hand, and the centrifugal force and the friction force of the bat on the splitting surface on the other, make up a couple of forces (moment) and tend to turn over, tighten the slice.

LITERATURE REVIEW

In the previously adopted regulated technological processes for processing raw cotton, the use of a screw (auger) cleaner 6A-12M for cleaning material from fine litter was envisaged [1]. The disadvantage of this cleaner is that the cylindrical pegs, when interacting with raw cotton, have a weak grip and unsatisfactory dragging over the mesh surface of the cleaner, which is one of the main reasons for the low cleaning effect of the equipment and, most importantly, the formation of defects in the form of harnesses. In some works, in particular, Lugachev A.E. [2]. To eliminate the aforementioned negative phenomenon, by reducing the moment of forces, small gaps (0-3 mm) between the prick and the mesh surface were proposed; however, this solution did not give a sufficiently positive effect. Also, in order to reduce the conditions of the flagellation, A. Sultonov [3] proposed to perform pegs not spherical at the ends, but cut off at a right angle to their longitudinal axis with blunting of sharp edges. The work [4] presents the results of studies to determine the optimal design parameters of the screw conveyor, which allowed an innovative approach to the design process of screw conveyors. It is proposed to change the geometry of the screw conveyor by adding three additional spirals, oriented in the same or opposite direction from the screw blades. The purpose of this study is to study the process of auger cleaning to eliminate the sounding of raw cotton (Fig. 1).,.

New design kolka. Elimination of the process of pinching cotton raw can be achieved by using, in the proposed spike auger 1, spikes 2, having the shape of a truncated cone, the upper base 3, which is located at an angle to the lower 4 and the working faces 5 of each groove, i.e. the faces that directly affect the material during its cleaning, form between themselves acute angle α, contributing more effective impact on the fibrous material in the cleaning process, as well as the location of the upper base 3 of the splitting 2 at an angle to the lower 4 and the presence of an acute angle α between the working edges of the splitting contribute to a better capture and longer retention of cotton particles in the cleaning process, as well as free flow material when moving to the next stage of processing (fig.1.)

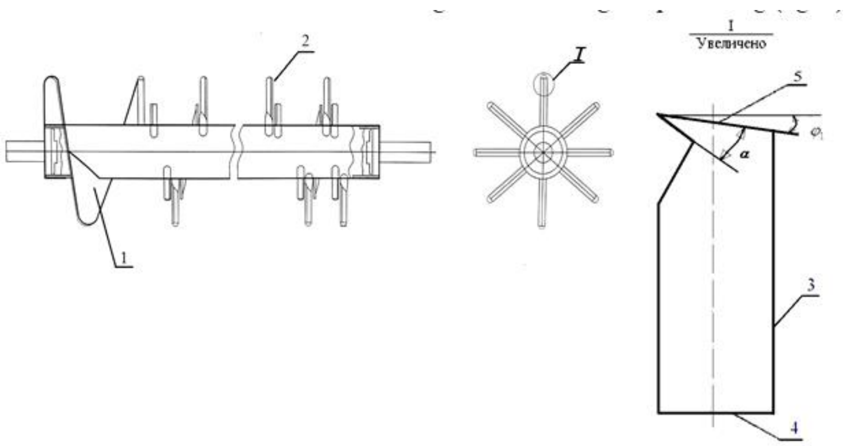

Fig.1. Kolkovy auger of fiber material cleaner

In operation, the material from the supply chamber (not shown in the drawing) enters the cleaning zone, where it gets under the shock-loosening effect of the pegs 2 of the proposed form, which securely capture them, not allowing harnesses, are dragged over the mesh surface (in the drawing shown). Due to this, there is an increase in the cleaning effect and a sharp decrease in the formation of malformations (flagellation). At one time, factors were considered that ensure the effective loosening of cotton and the removal of weed impurities and flaws on inclined cleaners with knives of new shape, where the working ends were milled and the front face was inclined with respect to the radius of the drum. However, in the theoretical part of this work, when choosing the angle of inclination of the front face, one of the main factors influencing the conditions of interaction between raw cotton and mesh surface in terms of gagging — the force of raw cotton friction on the mesh surface was not taken into account.

The results of theoretical studies. Consider the process of dragging a similar chopping of raw cotton over a mesh surface in order to determine the conditions for holding a chopping of raw cotton. When dragging raw cotton on a mesh surface, the following forces act on a splitting (Fig. 2).

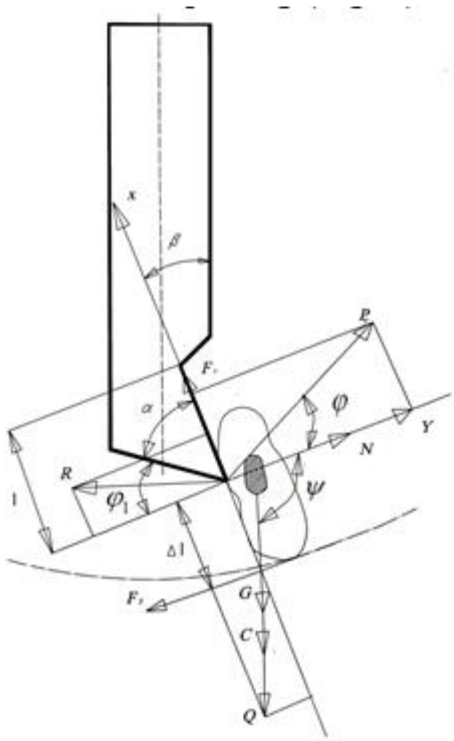

Fig.2. Scheme for determining the conditions of the clapping of raw cotton

G- raw cotton gravity;

C- centrifugal force;

R- aerodynamic power;

F1- friction force of raw cotton on the front surface of the spike;

F2 – friction force of raw cotton over a mesh surface;

N- kolka reaction;

P- force arising due to the screw movement of the spike.

- friction coefficient;

t- time;

m- weight;

From Fig. 1, it is clear that the forces G, C and F1 tend to tear the cotton-sқret from the splitting and roll it, while the forces R and F2, on the contrary, tend to press it to the splitting.

Let us find the conditions of equilibrium of forces, for this: we choose the coordinate with center 0 on the top of the spike, directing the X-X on the front face of the spike, and the axis of the Y-Y is perpendicular to it.

Then the equilibrium condition on the X axis:

$$m\ddot{x}_c = \sum F_x; \quad m\ddot{x}_c = F_1 + P\sin\varphi + R\sin\varphi_1 - Q\cos\psi \quad (1)$$

Wherein: $\varphi_1 = 90 - \alpha$

Here α - the angle of inclination of the front edge of the spike with respect to the radius of the drum, conducted through the top of the spike.

$$\ddot{x}_c = \frac{1}{m}(F_1 + P\sin\varphi + R\sin(90-\alpha) - Q\cos\psi) * t + c_1$$

(2)

Using the initial condition, we determine the constants for:

$t = 0 \quad \dot{x} = 0 \Rightarrow c_1 = 0$

$$\dot{x}_c = \frac{1}{m}(F_1 + P\sin\varphi + R\sin(90-\alpha) - Q\cos\psi) * t \quad (3)$$

$$x_c = \frac{1}{m}(F_1 + P\sin\varphi + R\sin(90-\alpha) - Q\cos\psi) * \frac{t^2}{2} + c_2 \quad (4)$$

Also using the initial condition, we determine the following constants for

$t = 0 \quad \dot{x} = 0 \Rightarrow c_2 = 0$

$$x_c = \frac{1}{m}(F_1 + P\sin\varphi + R\sin(90-\alpha) - Q\cos\psi) * \frac{t^2}{2} \quad (5)$$

Equilibrium condition along the У axis:

$$m\ddot{y}_c = \sum F_y; \quad m\ddot{y}_c = N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi \quad (6)$$

$$\ddot{y}_c = \frac{1}{m}(N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi) \quad (7)$$

$$\dot{y}_c = \frac{1}{m}(N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi) * t + c_3 \quad (8)$$

Using the initial condition, we determine the constants at

$t = 0 \quad \dot{x} = 0 \Rightarrow c_3 = 0$

$$\dot{y}_c = \frac{1}{m}(N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi) * t \quad (9)$$

$$y_c = \frac{1}{m}(N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi) * \frac{t^2}{2} + c_4$$

(10)

Also using the initial condition, we determine the constants:

$t = 0 \quad \dot{x} = 0 \Rightarrow c_4 = 0$

$$y_c = \frac{1}{m}(N + P\cos\varphi - F_2 - R\cos(90-\alpha) - Q\sin\psi) * \frac{t^2}{2} \quad (11)$$

It follows from the above equations that the forces F_2 and R really contribute to the capture of raw cotton by the hammer, and therefore, the sum of these forces must be greater than or equal to the sum of the other forces.

From (1) it follows:

$$P\sin\varphi + R\sin\varphi_1 + F_1 \geq G\cos\psi + C\cos\psi \qquad (12)$$

Or considering that

$$F_1 = \frac{N}{tg\alpha} \qquad (13)$$

$$P\sin\varphi + R\sin(90-\alpha) + \frac{\mathrm{N}}{\mathrm{tg}\alpha} \geq G\cos\psi + C\cos\psi \qquad (14)$$

$$N = \frac{C\sin\psi + G\sin\psi - R\cos(90-\alpha) - P\sin\varphi}{1+f} \qquad (15)$$

$$F_2 = f(C\sin\psi + G\sin\psi - R\cos(90-\alpha) - P\sin\varphi) \qquad (16)$$

From the above formulas, the following condition is satisfied:

$$\frac{f(C\sin\psi + G\sin\psi + R\cos(90-\alpha) + P\sin\varphi)}{1+f} \geq (C+G)\cos\psi$$

(17)

Since, the force of gravity G and the centrifugal force C act in the same direction and at the same angle for a given position, their action can be replaced by the resultant force Q:

$$Q = G + C$$

Then:

$$\frac{f(Q\sin\psi + R\cos(90-\alpha) + P\sin\varphi)}{1+f} \geq Q\cos\psi \qquad (18)$$

The differential equation of the moment of inertia referred to the point O.

$$I * E = \sum M(F_1); \qquad \frac{ml^2}{2} * E = N * l + P\cos\varphi - F_2(l+\Delta l) + M - R * l\cos\varphi_1 \qquad (19)$$

$$I_c = \frac{ml^2}{2}; \qquad \frac{ml}{2} * \ddot{x}_c = N * l + P\cos\varphi - F_2(l+\Delta l) + M - R * l\cos\varphi_1 \qquad (20)$$

$$a = \ddot{x}_c = E * R \qquad (21)$$

$$\frac{ml}{2} * \ddot{x}_c = N + P\cos\varphi - F_2(1+\frac{\Delta l}{l}) + \frac{M}{l} - R * \cos\varphi_1 \qquad (22)$$

$$\ddot{x}_c = \frac{2}{m}[N + P\cos\varphi - F_2(1+\frac{\Delta l}{l}) + \frac{M}{l} - R * \cos\varphi_1] \qquad (23)$$

Where:

E=2*10^5- elastic modulus; n/mm^2.

l- the length of the working part of Kolko; mm.

Δl- the gap between the spike and the mesh surface; mm.

M- moment; N*mm.

After small transformations and assuming that the coefficient of maximum friction force at rest is equal to the tangent of the angle at which the body begins to slide on an inclined plane, we can write the following inequality:

$$\frac{tg\varphi_2 + tg\alpha}{1 + tg\varphi_1 - tg\varphi_2 * tg\alpha} \geq \frac{Q}{R} \quad (24)$$

It can be used to determine the angle at which a particle of raw cotton will be held by a pick while moving relative to the mesh surface. The condition for the capture and retention of particles on the surface of the working bodies is determined by formulas (16) and (20). Thus, it is possible to choose such geometrical parameters of the chopping, in which the captured raw cotton will be reliably held on the cleaver and the friction forces on the mesh surface will not be able to tear it off and, consequently, twist it, creating the prerequisites for the formation of the lit cotton.

EXPERIMENTAL PART

The results of experimental studies. To assess the reality of the theoretical conclusions, experimental studies were conducted. On the basis of the theoretical analysis given above, new designs of pegs were made, with a suspended holding capacity of raw cotton, when it was cleaned.

The methodology of the experiments was as follows: the pegs were set on a rotating drum and to which a lump of raw cotton was tossed, part of which was picked up and thrown. The length of picking cotton particles was taken as an indicator of the efficiency of capture and dragging of raw cotton, and the length of the throw was determined by a ruler (Fig. 3.)

Fig.3. General view of the experimental setup

The results of the experiments, which were carried out in tenfold repetition, are presented in the form of a diagram (Fig. 4).

The angle of the pile prepared for the study is at different angles 150, 300, 450, 600 и 750 prepared by.

Number of drumming tracks n=260 min-1, n=350 min-1, n=500 min-1 denominations.

The results of the experiments, which were carried out in tenfold repetition, are presented in the form of a diagram (Fig. 4).

Table 1

The results of experimental studies

The number of revolutions, min^{-1}	Grinding angle				
	15^0	30^0	45^0	60^0	75^0
	Pallet travel distance, mm				
260	200	315	460	680	540
350	165	280	410	725	570
500	140	215	345	792	615

Analysis of the results of the experiments, as can be seen from table 1, shows that with screw cleaning of raw cotton, the ear with gripping angles of 600 and with a rotation frequency of n = 500 min-1 has the most exciting ability.

Fig. 4 presents a comparative diagram of pegs with casting fascinating ability.

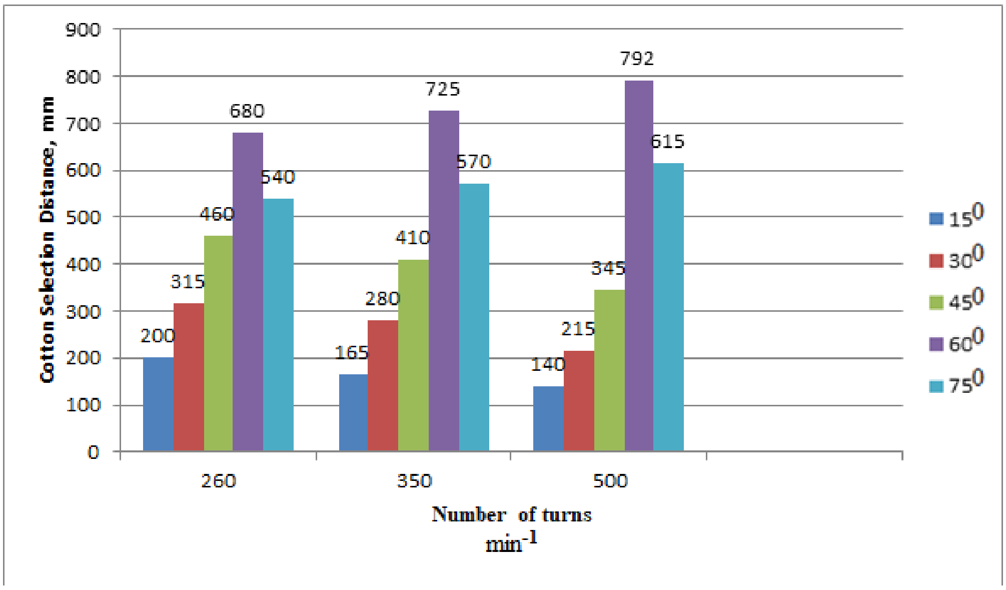

Fig.4. The influence of the angle of capture spike on its exciting ability

CONCLUSION

Experimental studies have established the fact of increasing the cleaning effect of a technological machine when using a screw cleaning method. To eliminate the negative phenomenon - raw cotton when cleaning it is proposed to apply pegs with a high exciting ability

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