Theoretical Research on the Processes of Cotton-Stage Linning and Lintering and Lintering

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ABSTRACT

The process of separating cotton fiber from seeds is very complicated. According to the current technological process, during the initial processing of cotton, after the ginning process, the surface of the seed is left with fibers capable of spinning. The presence of spinning fibers in the lint obtained during lintering and the fact that the total hairiness of the seeds is higher than the fruit limits the efficiency of the initial processing of cotton. In order to reduce the amount of short fibers in the fiber, increase the length of the staple mass of the fiber, reduce the amount of fibers in the fiber and the amount of fibers suitable for spinning and wool, as well as mechanical damage to the seed, the ginning process is different. density and the lintering process is carried out by softening the epidermal layer of the seed by additional moistening.

Keywords: Seed, Spinning, technology, saw, power, fiber, kolosnik, gin, shaft

It is expedient to solve the following theoretical problems of the proposed technological process:

- Determining the calculation of the separation of cotton fiber from seeds during the first and second stages of ginning;
- Determining the size of a cotton seed depending on its fineness;
- Determining the distance between saws when spinning seeds with spinning fibers;
- Determining the distance between saws when spinning seeds with spinning fibers;
- study of the friction force of the hairy seed on the surface of the sawdust at the distance between the saws;

- to study the movement of a set of fibers suitable for spinning under the saw teeth;
- study of the working diameter of the saw blade when spinning fibers suitable for spinning;
- to determine the binding strength of the fluff in the addition of moistened seeds;
- to determine the effect of additional moistened seeds on changes in linter performance;
- calculate the time of separation of fluff from additional moistened seeds;
- Determine the dependence of the fluff mass separated from the extra moistened

seed on the strength of its separation from the seed.

2.1 Calculation of fiber separation from seeds during two-stage ginning

The process of separating cotton fiber from seeds is unique and requires a number of conditions. In ginning, it is important to ensure high productivity, to produce more fiber and to maintain high quality fibers and seeds.

In the process of separating the cotton fiber from the seeds, the saw teeth of the gin saw enter the raw material roller, attach the bundles of fibers (tufts or twigs) and separate them from the seeds by passing them through the threads of the columns. It should be noted that according to [19], each set of cotton fibers (tuft) is covered by 3 ÷ 4 saw teeth, even if they are attached to one saw tooth. Cotton fibers are extracted from the saw teeth by a stream of air flowing from the nozzle at a high speed (55 ÷ 65 m / s) [27]. The seeds roll (slip) from the sloping surfaces of the columnar grate, between the saw and the seed comb pegs, and then into the collecting auger [27]. It is known that after germination, the resulting seeds, in addition to down, contain fibers that can be spun [10]. Therefore, in order to increase the fiber yield by completely separating the fibers suitable for spinning in the seed, it is necessary to create a second stage short staple fiber gin [44]. The seeds that emerge after the short staple fiber gin have almost no spinning fibers [47]. In this genie, the separation of the fibers suitable for spinning from the ginned seed can be done by sawing and removing the fiber bundle from the seed in the working area. In both cases, the process of separating the fibers from the seeds is not always normal. The binding strength of the saw blade fiber bundle may not be sufficient to separate them from the seed. In some cases, the fiber bundle may slip off the surface of the saw tooth. Therefore, it is important to determine the effect of ginning modes (saw tooth size, tooth thickness, saw blade cutting angle, saw spacing, saw blade access to the raw material shaft, etc.) on the process of separating spinning fibers from seeds. Therefore, we perform the appropriate calculations. It is known that the average mass of a fibrous seed [15] is m_n = 0.175 g, and the average mass of a single seed is 0.08 ÷ 0.12 g. In this case, the mass of the seed is 66% of the fiber, and 34% of the cotton fiber. It should be noted that a fibrous seed can contain up to 7,000 ÷ 15,000 fibers [20] and the binding strength of each fiber to the seed (in the epidermis) is 2.0 ÷ 3.5 g [15]. Given the above, we can determine the average mass of a single fiber by the following expression .

$$m_m = \frac{k \cdot m_n}{n} \qquad (2.1)$$

Here

k is the coefficient that determines the percentage of fiber in the seed relative to the total mass of the seed; 34 percent and k = 0.34;

m_n-fiber seed mass, m_n = 0.175 g;

n is the number of fibers on the surface of a seed, n = 7000 ÷ 15000.

The fineness of the seed is determined by the amount of fiber attached to the surface of the seed. In general, the fineness of unginned fibrous seeds is considered to be 100%. In particular, if the fluff is reduced by 0.7%, 49 fibers can be obtained from 7,000 fibers and 105 fibers from 15,000 fibers. It should be noted that the saw teeth can also be removed from the seed by scraping the fibers suitable for spinning. We now give the corresponding calculations for the detection of fibers separated from the seed during both stages of germination.

2.1.1. The first step is the calculation of the cotton fiber by the ginning process

As mentioned above, the average mass of a fibrous seed is 0.175 g [15], and the mass of the fiber in it is 0.0595 g. Given that the number of fibers in each fiber is in the range of 7,000 to 15,000, it can be noted that the average fiber content is around 13,000. In this case, if we determine the average mass of a single cotton fiber using the expression (2.1), the value is m_m = 4.58 · 〖10〗 ^ (- 6) g. Taking into account that the mass of fibers in one saw tooth is m_m = 8.7 · 〖10〗 ^ (- 4) g, we can determine the number of corresponding cotton fibers.

$n_m = \frac{m_a}{m_m} = 189$ Fiber

Here m_a is the average mass of fibers in one saw tooth,

$$m_a = 4{,}58 \cdot 10^{-6} \cdot 189 = 8{,}7 \cdot 10^{-4} g$$

This value is 1.45% of the fiber output. It is known that the productivity of a sawmill is determined by the number of kilograms of sawdust. In this case, the performance of a single saw is determined by the following expression

$m_{ap} = i \cdot n \cdot m_a$ (2.2)

Here the number of saw teeth on the i-saw vertical, i = 280, the number of revolutions per minute of the n-saw stylus, n = 730 r / min; m_a = 8.7 · 〖10〗 ^ (- 4) g.

Based on the given values, the average productivity of one saw in the first stage of ginning is 10.6 kg of fiber / saw h.

It is known that the fiber staple lengths on the surface of the fibrous seed are 31 <l_m <36 mm [27]. Assuming that the average length of the fibers is l_{ur} = 33.0 mm, we can determine the mass of the fiber per millimeter.

$\Delta l_m = \frac{m_m}{l_{ur}}$ (2.3)

Here l_{ur} − the average length of cotton fiber obtained during the first stage ginning, l_{ur} = 33,0 mm

in that case $\Delta l_m = 0{,}14 \cdot 10^{-4}\ g/mm$.

As mentioned above, a set of cotton fibers will cover 3 ÷ 4 saw teeth. In this case, if the average number of fibers per tooth is 189, then at least 567 fibers are needed to collect the fibers, which means that the saw tooth can hold as many fibers. . If, according to [15], the binding strength of each fiber to the seed is assumed to be 2.0 ÷ 3.5 g, the total binding strength of the fiber bundle to the seed at a working yield of 10.6 kg / (saw h) in the first stage ginning is 1134 ÷ 1984 , Is 5 g. So, to separate this set of fibers from the seed, you have to overcome this force.

2.1.2. The second step is to count the fibers that can be spun from the ginned seed

State Standard of Uzbekistan O'z Dst 604-2001 "Cotton fiber" In accordance with the requirements of the technical specifications, the second stage of spinning is based on spinning. The mass of each fiber is 4.09 · 〖10〗 ^ (- 6) g.

The second stage of the ginning process is defined by the following expression:

$M_2 = 60 \cdot i_2 \cdot n_2 \cdot k \cdot q$ (kg / machine h) (2.4)

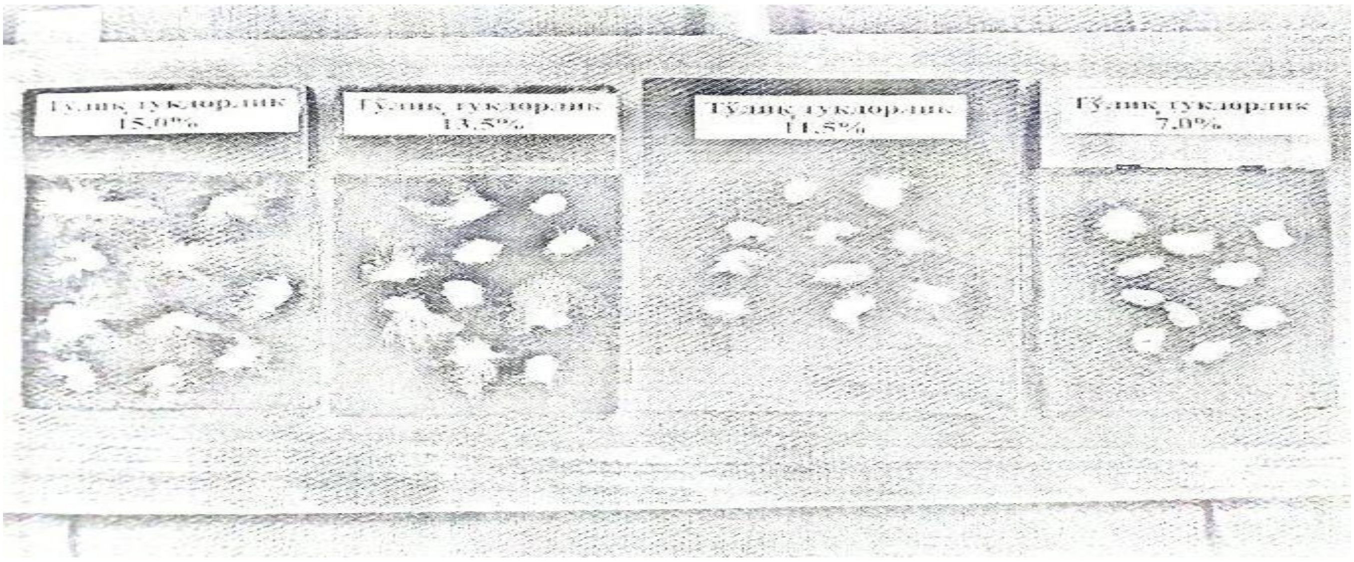
Here, the number of saw teeth on the i_2-saw disc is i_2 = 330; the number of revolutions per minute of the n_2-saw cylinder, n = 730 r / min; k- number of saw discs, k = 119; q is the number of fibers per saw tooth.

If each saw tooth connects one fiber to the seed, the productivity of the saw is m_2 = 6.93 kg / (machine h). If the number of fibers suitable for spinning is 6 per saw tooth, the productivity of the second stage ginning is 41.5 kg / (machine h).

In general, the fiber yield in the first stage is 1.1% on average compared to the germinated seed, while the fiber yield produced is 0.51%.

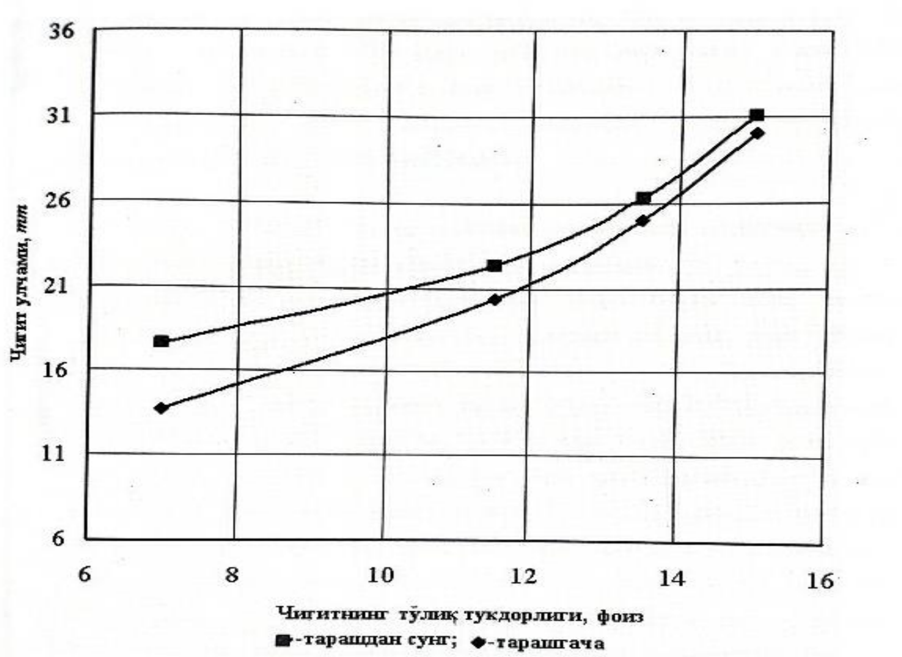
2.2 The effect of seed fluff on its geometric dimensions

Residual hairiness after sowing can be 11.1 ÷ 12.6% (∓0.5%) depending on the regimes, technological parameters and varieties of cotton selection [47]. The proposed second stage is when the fibers that are suitable for spinning are separated from the seeds, that is, when the fibers that are suitable for spinning are separated from the seeds, there are almost no ginned seeds after the jinn. The fluff of the seed mainly determines the geometric dimensions of the seed. We conducted experimental studies to determine the seeds of different hairs with spinning fibers, depending on their geometric dimensions. The experiment was conducted in two variants. In the first case, the values of the seeds of different hairs were calculated from the values before combing the fibers. In the second variant, the values of the seeds of different hairs were calculated after the spread of the fibers. Figure 2.2.1 shows photographs of post-sowing specimens with a fineness of 7 to 15%. The geometric dimensions of 10 seeds for each variant were measured using a micrometer for pre- and post-shear conditions. The experiments were performed on 7%, 11%, 13.5% and 15% fluffy seeds. Based on the results obtained, graphs representing the effect of seed fluff on its geometric size were constructed based on the pre- and post-spinning dimensions of the fibers (Figure 2.2.2). The analysis of the obtained results shows that as the seed fluff increases, its size also increases, and this connection becomes nonlinear. Also, the difference between the size of the fibers in the unfolded and scattered states of the seeds, which are not completely ginned, decreases with increasing hairiness (Figure 2.2.2).Post-propagation photos of seeds of different full-fledged



2.2.1- picture

Graphs of changes in the size of the seed depending on its total fineness



2.2.2-Picture

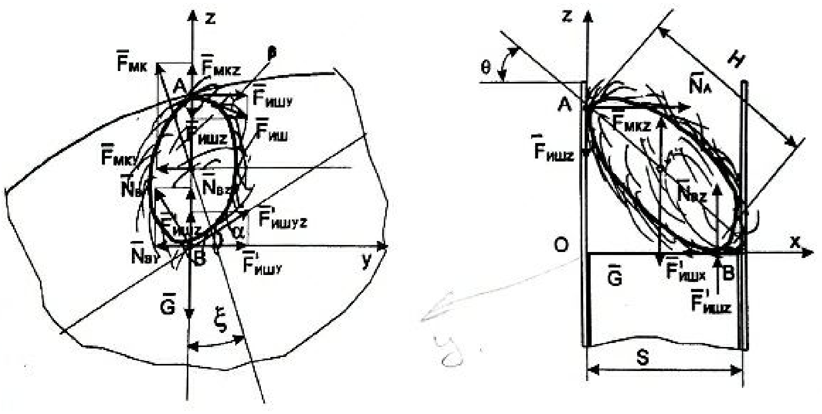
This is because the size of the seeds with high hairs has almost no effect on the size of the comb. The results showed that at 7% seed germination, the difference in seed size before and after sowing was 3.9 mm, while at 15% seed germination, the difference was 1.05 mm [46]. The results obtained are used to substantiate the saw distance for spinning seeds with spinning fibers on a kata staple fiber machine.

2.3. Determining the distance between saws when spinning seeds with spinning fibers

In addition to a number of factors, the sawing distance also has a corresponding effect on the process of ginning. In general, the saw distance has a significant effect on seed germination, cotton fiber seed quality, and machine performance. The results of research by TS Saidkhodjayev and GI Boldinsky [16, 45] mainly reduce the distance between the saws, which leads to a decrease in fiber length to 0.3 ÷ 1.5 mm, an increase in the amount of fiber obtained in the raw material roller and a decrease in its fineness. An increase in the number of fibers in the raw material roller leads to an increase in the number of broken seeds and hull fibers. The authors of this study [48] suggested that the optimal value of the saw spacing was 17.30 mm. In fact, as the saw spacing decreases, the productivity increases with the machine hour, but as the saw hour decreases, the product quality decreases. Based on the analysis of studies conducted at different values of the saw distance from the saw blade, it can be concluded that it is advisable to choose the value of the saw spacing distance depending on the fineness of the seeds, which are fibers suitable for spinning.

In order to obtain high-quality cotton fiber, seeds and increase the yield of fiber, it is necessary to develop and put into practice a step-by-step ginning technological process. In the first stage, the length of the fiber obtained in ginning (5DP-130, DPZ-180) is almost the same length, and the total fineness of the seed averages 12.6% (± 0.5%) [49].

In the second stage, mainly short staple lengths (29.2 mm and longer) are obtained. The fibers obtained in both stages are not mixed and transported separately. It is known that the fluffiness of seeds with spinning fibers determines their geometric dimensions. In turn, the geometric dimensions of the hairy seeds play a special role in choosing the saw distance. Therefore, it is important to study the effect of the fineness of the seeds, the angular velocity of the saw blade, the geometric dimensions of the seed and other parameters on the sawdust, which are suitable for spinning the saw distance. For this, an accounting scheme was developed (Figure 2.3.1). According to this calculation scheme (see Figure 2.3.1), the following forces act on the equilibrium seed: $\vec{G}$-weight; $\vec{F}$ MK - forces of processing of hairy seeds with saws and gable surfaces; $\vec{F}$ISh, $\vec{F}$ISh - sawing forces and bristle surfaces of hairy seeds; $\vec{F}$I is the force of inertia. The deformation of the seed during the ginning process is conventionally assumed to be a rigid body due to the fact that it is very small. In this case, the interconnection of the required seeds is recorded by the coupling force. It should be noted that in the equilibrium position, the hairy seed is assumed not to move relative to the saw and the chisel, so the value of the inertial force is assumed to be zero. In this case, considering the seeds with residual spinning fibers in equilibrium, we can write [50 ÷ 54]: Calculation scheme for determining the distance between the saws in the spinning of seeds with spinning fibers



2.3.1-Picture

$$\sum_{i=1}^{n} P_{Xi} = 0; \quad \sum_{i=1}^{n} P_{Yi} = 0; \quad \sum_{i=1}^{n} M(P_i)_y = 0;$$

$$\sum_{i=1}^{n} P_{Zi} = 0; \quad \sum_{i=1}^{n} M(P_i)_Z = 0;$$

Equations of momentum, force on the axes, taking into account the forces acting on the hair seed

$$F^{\mathrm{I}}{}_{ish.y} + F_{ish.y} - N_{By} - F_{MK} \cdot \sin\xi = 0;$$

$$F^{\mathrm{I}}{}_{ish.Z} - F_{ish.z} - G + F_{MK} \cdot \cos\xi + N_{Bz} = 0;$$

$$-F^{\mathrm{I}}{}_{ish.x} + N_A = 0;$$

$$-F^{\mathrm{I}}{}_{ish.y} \cdot H \cdot \cos\theta - F_{MK} \cdot \sin\xi \cdot \frac{S}{2} = 0;$$

$$-m \cdot q \cdot \frac{S}{2} + F_{MK} \cdot \cos\xi - N_A \cdot H \cdot \sin\theta + N_{Bz} \cdot H \cdot \cos\theta + -F^{\mathrm{I}}{}_{ish.y} \cdot H \cdot \cos\theta = 0 \quad (2.6)$$

Here, b is the measure of the friction force of the hairy seed against the saw blade surface; S- saw distance; f_1, f_2- coefficients of friction of hairy seeds with saw and chisel surfaces; the angle of inclination of the α-column relative to the XOY plane; g is the angle formed by the friction force with the Y axis at point B; the angle of inclination of the th-haired seed relative to the surface of the column is the angle between the centrifugal force vector and the vertical OZ axis.

It should be noted that F_ishkuchi ZOY in the plane,; N ⃗A is on the OX axis, G is the gravitational force on the OZ axis, and F ⃗ is the ZOY force. We can write with the following in mind:

$$F_{ish} = \sqrt{F_{ish.z}^2 + F_{ish.y}^2}, \quad F_{ish}^{\mathrm{I}} = \sqrt{F_{ish}{}^{\mathrm{I}^2} + F_{ish.z}^2 + F_{ish.y}^2}$$

$$N_B = \sqrt{N_{b.y}^2 + N_{B.z}^2}$$

$$F_{ish} = \sqrt{F_{MK.y}^2 + F_{MK.z}^2} \quad (2.7)$$

Considering the following:

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