

## SEED ROLLER, ITS CHARACTERISTICS, AND ITS INFLUENCE ON THE LINTERING PROCESS

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**Introduction.** The process of linting cotton seeds is determined by a complex of design and technological factors, among which the operation of the mixer is of primary importance. The quality of lint separation, the degree of seed damage, and the overall productivity of the linter unit depend on the uniform supply of the seed stream [1], [2]. The cultivator plays a key role in distributing the seed flow, influencing the uniform delivery of material to the working chamber, the degree of fiber cleaning, and the degree of seed damage. This chapter examines the methodology for theoretically substantiating the feasibility of implementing an improved 5-blade inclination-free mixer by analyzing its impact on seed retention time in the working chamber, uniform lintering, and mechanical impact on seeds.

**Main part.** In the models of 5LP linters, 4-lobed mixers are used, as well as previously introduced new designs with a change in the angle of inclination and replaced the sprocket part with elastic discs with an angle of inclination of 30°, however, when operating the mixers proposed by them in cotton ginning plants, a number of shortcomings were revealed:

Reducing the uniformity of seed feed, which leads to an increase in the amount of clogging in the lint, as well as leading to the displacement of incoming seeds in one direction of the working chamber. Increased mechanical impact on seeds, leading to their destruction. In this regard, an improved 5-lobed stirrer without an inclination angle (0°) is proposed in this study. This design is expected to improve lint quality, reduce seed damage, and improve lint separation characteristics in the working chamber.

At the first stage of the research, a comparative analysis of the existing mixer designs is carried out, their shortcomings and promising directions for modernization are identified. The main attention is paid to the following parameters:

Uniformity of seed delivery to the working chamber.

Cleaning effect (content of impurities in lint).

Air flow velocity and its effect on seed movement.

Degree of mechanical damage to seeds during linting.

In the working chamber, the seeds, under the influence of a rotating stirrer, form a seed roller, in which they, under the mechanical action of saws, are freed from lint. With a steady-state process, the expression is valid for the linter's working chamber [1]:

$$\Pi_c = \frac{q}{\tau} A \quad (3.1)$$

where:  $\Pi_c$ - productivity of the working chamber for seeds;

$q$ - seed roller weight;

$\tau$ - average time of seed retention in the chamber;

$A$ - steady-state process constant in the working chamber;

$$A = \frac{100 - C_{cp}}{100 - C_1} \quad (3.2)$$

$C_{cp}$ - Average seed pubescence in the working chamber %;

$C_1$ - hairiness of seeds entering the working chamber.

From expression 3.1, it follows that the increase in linter productivity can be achieved by 1) increasing the weight of the seed roller ( $q$ )

2) By reducing the duration of seeds in the working chamber ( $\tau$ )

According to G. Miroshnichenko [1] "Fundamentals of designing cotton primary processing machines," with a decrease in seed residence time in the working chamber, the productivity of the Linter machine increases. Calculations for determining the characteristics of the seed roller were carried out according to the book "Physics of Textile Materials" by A. G. Kuznetsov, 1995.

Formula for determining the mass of the seed roller [2]:

$$Q = \rho \cdot V \quad (3.3)$$

where:

–  $\rho = 700 \text{ kg/m}^3$  – seed density,

–  $V = A \cdot h$  – seed layer volume,

–  $A = 0.3 \text{ m}$ , – chamber width,

–  $h$  – seed roller thickness

mass of the seed roller with a 4-lobed stirrer:

$$q_4 = 700 \times (0.3 \times 0.06) = 12.6 \text{ kg} \quad (3.4)$$

mass of the seed roller with a 5-lobed stirrer:

$$q_5 = 700 \times (0.3 \times 0.05) = 10.5 \text{ kg} \quad (3.5)$$

The mass of the seed roller in the 5-lobed mixer decreases by 2.1 kg due to the reduction of its thickness.

Tables 1. Calculated data of seed roller characteristics

Indicator	4-lobed	5-lobed
Layer thickness, m	0,06	0,05
Roller weight, kg	12,6	10,5
Pressure, Pa	411,2	342,7
Stay time, from	9,4	7,52

As can be seen from the table, the decrease in layer thickness during the transition to a five-blade mixer reduces the seed roller mass by 2.1 kg (16.6%) and the pressure on the saw cylinder by 16.6%. This leads to a reduction in mechanical impact on the seeds and prevents their destruction. The seed movement speed increases from 0.2 to 0.25 m/s when rotation frequency increases from 480 to 600 rpm. The seed residence time in the working chamber decreases by 1.88 s, which, according to [1], contributes to increased productivity without deteriorating lint quality. According to Miroschnichenko, this reduces linter productivity, but according to the second factor "seed time in the working chamber," productivity increases [1] [2].

Also, the pressure indicators of the seed roller on the saw cylinder take on other values:

Seed roller pressure

$$P = \rho \cdot g \cdot h \quad (3.6)$$

where:

$g=9.81\text{M}/\text{c}^2$  - acceleration due to gravity.

4-blade stirrer:

$$P_4 = 700 \times 9.81 \times 0.06 = 411.2\text{Pa} \quad (3.7)$$

5-blade stirrer:

$$P_5 = 700 \times 9.81 \times 0.05 = 342.7\text{Pa} \quad (3.8)$$

The seed roller pressure on the working chamber in the 5-lobed mixer decreases by 16.6%. This prevents the saw cylinder from being overloaded, reduces mechanical damage to seeds, and contributes to more efficient lint separation [5],[6].

Calculation of seed residence time in the working chamber:

$$t = \frac{L}{v} \quad (3.9)$$

where:

$L=1.88\text{ M}$  - working chamber length,

$v$  - seed movement speed.

$N_4=480\text{ rpm}$  - rotational speed in a 4-lobed stirrer,

$N_5=600\text{ rpm}$  - rotational speed in a 5-lobed stirrer.

Determination of the seed movement speed proportional to the rotation frequency:

$$v_5 = v_4 \times \frac{N_5}{N_4} \quad (3.10)$$

At 480 rpm, the seed movement speed was 0.2 m/s, which means at 600 rpm:

$$v_5 = 0.2 \times \frac{600}{480} = 0.25 \text{ m/s} \quad (3.11)$$

Calculation of stay time

For a 4-lobed stirrer (480 rpm,  $v = 0.2$  m/s):

$$t_4 = \frac{1.88}{0.2} = 9.4 \text{ s} \quad (3.12)$$

For a 5-lobed stirrer (600 rpm,  $v = 0.25$  m/s):

$$t_5 = \frac{1.88}{0.25} = 7.52 \text{ s} \quad (3.13)$$

The seed residence time in the working chamber decreases from 9.4 seconds to 7.52 seconds when switching to a 5-lobed stirrer, which means:

The seeds pass through the working chamber faster, reducing overload and clogging.

**Results and Discussion.** Reducing the mass and pressure of the seed roller improves lint separation conditions by reducing the layer compaction. The five-blade mixer forms a more stable air-seed flow that excludes stagnant zones and cylinder overload. Thus, the optimal ratio between the contact time and the intensity of the mechanical impact is ensured, which improves the quality of linting.

**Conclusion.** The proposed design of a five-blade mixer without an inclination angle provides:

- 1) uniform distribution of seeds along the length of the working chamber;
- 2) reduction of seed roller pressure on the saw cylinder by 16-17%;
- 3) reduction of seed residence time in the working chamber by 20%;
- 4) increasing the stability of the linting process and the quality of the resulting lint.

Thus, the improved stirrer is a promising direction for modernizing linter units, allowing for increased productivity without deteriorating cleaning indicators and without increasing the degree of seed damage.

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