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The Theoretical Basis of Soybean Cutting Process and Knife Selection

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ANNOTATION

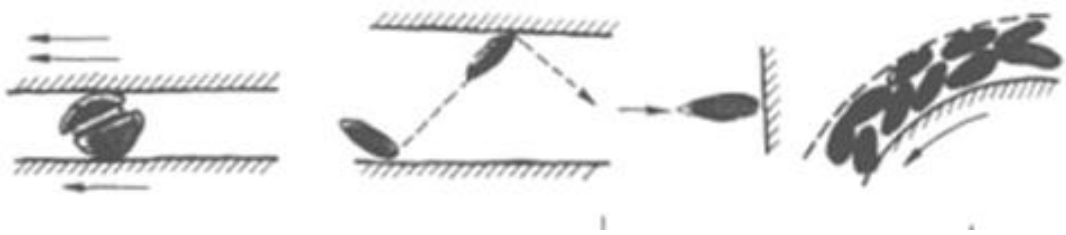
This scientific research presents that a theoretical analysis of the methods and forces involved in the soybean seeding process. Detailed information on the projection of forces, the effect of forces on the working body of the soybean seeding device is given.

KEYWORDS: *Soybean, knife, force, чақиш, coefficient of separation.*

Introduction. In the Republic of Uzbekistan, 80,400 hectares of soybeans were planted in 2022, and 6,700 tons of seeds were used for planting in these areas. It is planned to collect 165,000 tons of soybean seeds from these areas. 15,000 tons of these seeds will be stored for seed, and 150,000 tons of soybean seeds will be processed. As a result, 30,000 tons of soybean oil and 113,000 tons of soybean meal are produced [1].

Researching methods. The effectiveness of the process of grinding soybeans depends mainly on the strength of their shell and the method of grinding.

The stinging method is mainly carried out in 3 ways (Fig. 1): a) stinging by squeezing; b) sting through impact; c) rapid stinging by gnawing the shell. [2]



а *б* *в*

Figure 1. Ways to cutting seeds

In our research, the shock method was selected from the stinging methods, and the seeds were hit by the blade rather than the shell of the device. This method is a new method of impact stinging, where the sting is increased as the seeds hit the blade.

The effectiveness of the cut is evaluated by two indicators - quantitative and qualitative. Quantitative indicator is the cut coefficient expressed as a percentage [3]:

$$K_a = (H_1 - H_2)\times 100 / H_1, \qquad (1)$$

where H_1 and H_2- the content of seeds in the product entering and leaving the machine, %.

The angle at which the seed falls is important to the germination process and can be described as follows.

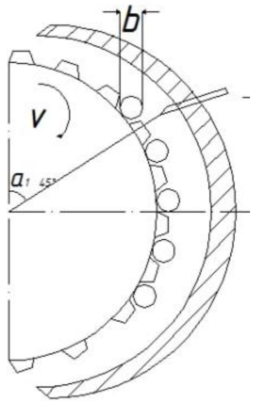


Figure 2. The working part of cutting soybean seeds.

In this case, the angle of inclination of the blade is calculated by the following expression:

$$\cos\varphi = \frac{R + c/2}{R + b/2} = \frac{d + c}{d + b} \quad (2)$$

where R –shaft radius, mm;

d – shaft diameter, mm;

c- gap between blade and shaft, mm;

b- soybean seed size, mm.

So that,

$$< \varphi = arccos\frac{d + c}{d + b}$$

Results. The distance between the drum and the blade is 2 mm. 2/3 of the soybean seeds are placed in the hole prepared for the shaft [4]. Taking into account the uniform distribution of soybean seeds in the device, the cut zone is found as follows:

$$K_a = 2\frac{nD}{360}\ arccos\frac{d + c}{d + b}, \quad (3)$$

(3) as can be seen from the expression, the cut zone depends on the drum rotation speed, the diameter of the shaft, the diameter of the seed, and the distance between the blade and the shaft.

In the prepared device, the time for soybean seeds to pass through the cut zone is determined as follows

$$T = \frac{K_a}{\vartheta_b}, \quad (4)$$

Let's consider the following scheme to study the elasticity property of soybean seeds.

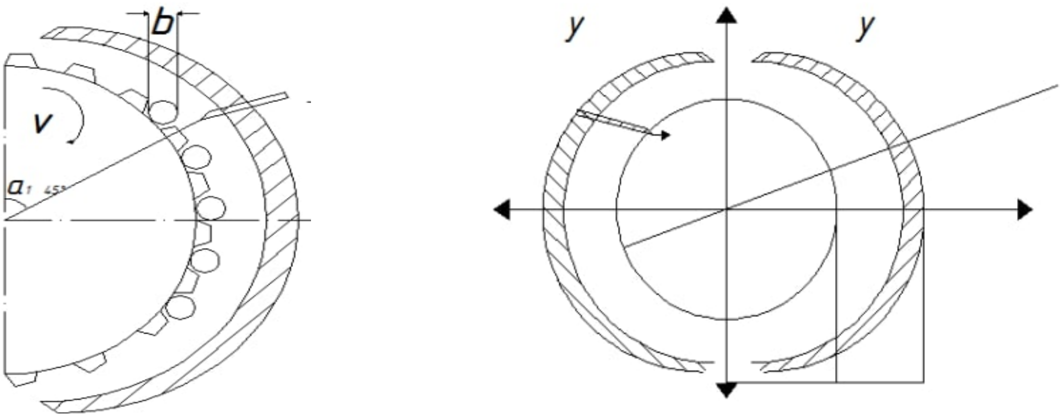


Figure 3. The scheme of studying the elasticity of soybean seeds.

Soybean is absolutely elastic when it hits the knife. Since the deformation value of the blade is small, it can be ignored. After the soybean seeds are sent to the device, they hit the knife, and the maximum force is spent in the collision zone with the knife [5].

Discussions

The power consumption can be seen in the diagram below.

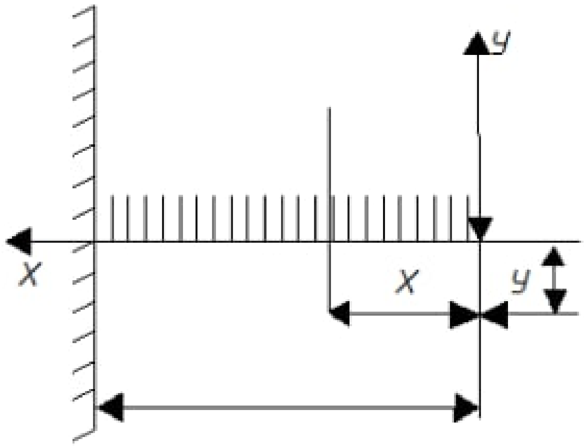


Figure 4. Diagram of the distribution of forces during the deformation and destruction of soybean seeds.

For a cross-section with coordinate X, the deflection Y is determined by the following equation.

$$\frac{EY(x)dy^2}{dx^2} = M(x) \quad (5)$$

Bending moment

$$M(\mathrm{x}) = -P_{mp}\,x; \quad (6)$$

The "minus" sign represents the bending of soybean seeds from tension in the upper layer. E - modulus of elasticity; Moment of inertia depending on Y – X coordinate

$$Y(x) = \frac{PZ^4}{4} \quad (7)$$

Conclusion. In the process of biting, the structure and material of the main working (cutting, biting) organ is of great importance. There are several requirements for the stinger used in stinging devices: it must be resistant to mechanical force and heat, the material must not be scarce, it must be corrosion resistant, it must not have a negative effect on the quality of the stinging product, it must be cheap, etc. Knives made of known high-strength steels meet the above requirements. With this in mind, we choose the St25 steel grade based on the amount of force required to crush locally grown soybeans.

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