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Theoretical Study of the Process of Separation of Agricultural Crops Seeds from Heads and Pods under the Influence of Winders

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Abstract: The article provides information on the theoretical research of the process of separating grain from ears and pods under the influence of the device that separates grain from ears and pods of agricultural crops. The results of theoretical studies showed that the structure and its main structural dimensions and work modes were optimized. The results of the experimental research showed that the value of the force exerted by the harvester should be about =7,9 H in order to separate the grain of agricultural crops from the ears and pods.

Keywords: Agricultural crops seed, legume, device, screw shaft, cogwheel, deformation, moment of inertia, moment of force.

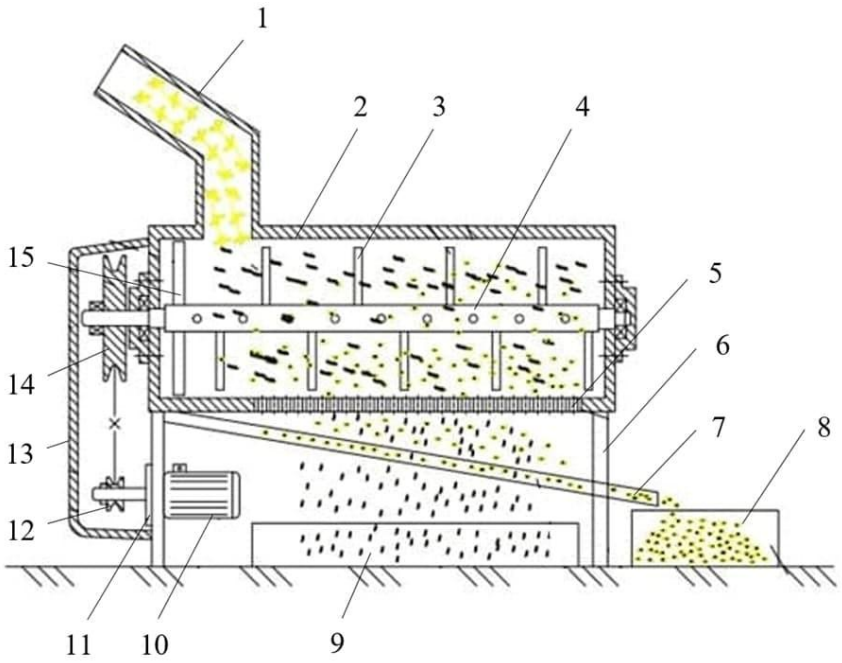
Relevance of the topic. It is known that today, to separate the seeds of agricultural crops from the ears and pods, complex in terms of structure, high productivity and powerful combine harvesters are used. These combine harvesters have the ability to harvest the cultivated crop quickly and with high quality, and their use in farms engaged in seed production is not economically justified. Taking this into account, in connection with the establishment of farmers and farms in agriculture in the following years, in order to properly implement seed production, to separate the seeds of agricultural crops from ears and pods. the need for energy and resource efficient devices was born. Because each farm, based on its needs, will have the opportunity to prepare the necessary amount of seeds from the seeds of cultivated agricultural crops. Therefore, the development of an energy and resource-efficient device for separating the seeds of agricultural crops from the pods and pods, meeting the needs of farmers and farms, and justifying its parameters is very urgent and of great importance for the national economy of the Republic. Have Level of study of the subject. In foreign countries, including Russia, a certain amount of scientific research work has been carried out on the development of shredders that separate seeds from pods and pods, as well as on the justification of their structural dimensions and operating modes [1,2]. However, the structure of the devices developed by them is complex, and in the technological process of separating the seeds from the ears and pods of agricultural crops, there is sufficient theoretical justification of the separation of the seeds from the ears and pods under the influence of savages. no studies have been conducted.

The purpose of the study. Theoretical substantiation of the process of separating the seeds of agricultural crops from the ears and pods without damage due to the interaction with the piles fixed to the shaft of the device in the form of a screw.

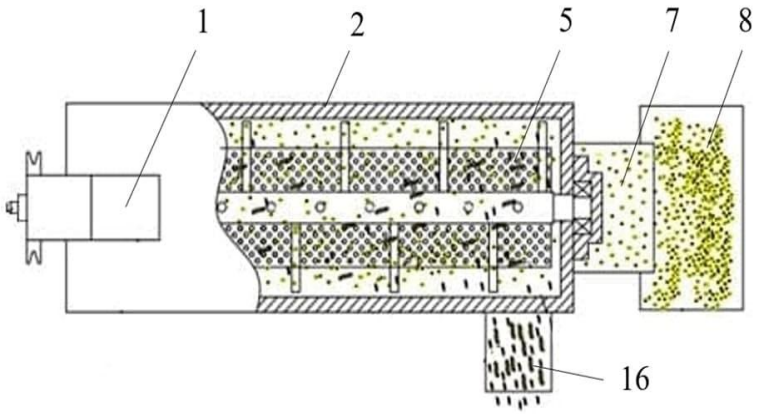
Research methods and materials. In the theoretical study of the process of separating the seeds of agricultural crops from the cobs and pods with the helpers attached to the shaft of the device in the form of a screw, the laws and rules of theoretical mechanics were used on the basis of mathematical analysis.

Research results. As a result of patent research, preliminary theoretical and experimental research, a special device was developed for separating the seeds of agricultural crops from the ears and pods [3,4,5,6,7,8,9,10,11, 12].

Figure 1 shows the principle scheme of the device developed for separating the seeds of agricultural crops from the pods and pods.



a)



b)

a) side view; b) top view 1 – transmission channel; 2- hollow cylinder; 3-gifts; 4-shaft; 5- gular base; 6-frame; 7-grid device; 8-hopper for seeds; 9 – hopper for small mixtures;

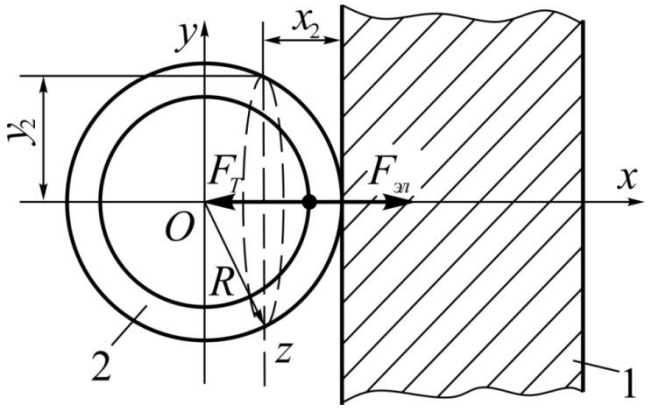
10-electric motor; 11th basis; 12 and 14 pulleys; 13-protective device;

15-parak; 16-exit hole

Figure 1. Constructive and technological scheme of the device that separates the seeds of agricultural crops from the ears and pods

In order to visualize the separation of the seeds of agricultural crops from the cobs and pods during the technological operation of the device, it is necessary to study the interaction of the cobs with the cobs or pods. For this purpose, we will consider the process of separation of seeds from them as a result of FT, the force of influence of savages on spikes or pods.

The blades attached to the shaft of the device rotate with it and hit the stalks of spiked and leguminous seeds. In this case, as a result of the impact force FT shown by the saw, the seed head or pod 2 is compressed against the x-axis and stretched against the y-axis (Fig. 2).



1-savagich; 2-seed head or pod

Figure 2. Scheme of interaction between savagich and agricultural crop seed cob or pod

The compressive moment M(y2) is the compressive moment M(y2) produced by the coulter on the ear or pods of the grain of agricultural crops passing through the center of the ear or pod. The equation of the relationship between the moment of inertia J(y2) with respect to the y-axis is equal to the following [13]

$$\frac{EJ(y_2)d^2x_2}{dy_2^2} = M(y_2), \quad (1)$$

Here E – modulus of elasticity of the seed head or pod, Pa;

x_2 – deformation of the seed head or pod along the x axis, m;

y_2 – deformation of the seed head or pod along the y axis, m;

$M(y_2)$– moment of force that compresses the spike or pod under the impact force, N·m;

$J(y_2)$- the moment of inertia of the spike or pod relative to the y axis, m4.

According to the scheme shown in Fig. 2, when the seed head or pod interacts with the grain, F_T=–F_{el} that is, the force F_T is equal to the value of the elastic force F_{el} lib, directed against each other.

Impact force F_T is equal to the moment of the compressive force due to the moment of the elastic force and is opposite in direction.

$M(y_2) = F_{эл}y_2$ It is spherical in shape, and the moment of inertia relative to the y-axis passing through the center of the seed head or pod is equal to

$$J(y_2) = \frac{\pi z_2^4}{4}, \quad (2)$$

Where z_2 – is the deformation of the seed head or pod along the z axis, m.

Figure 3 shows the moment of inertia calculation scheme.

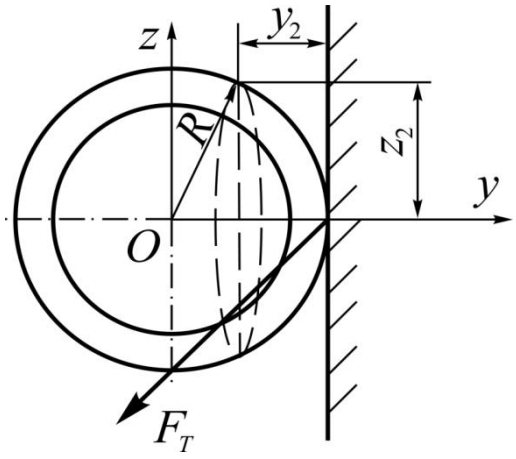


Figure 3.8. Calculation scheme of the moment of inertia

Based on the scheme shown in the picture, we will make the equation of the sphere

$$z_2^{\,2} + (R - y_2)^2 = R^2, \text{ (3)}$$

Here R – average medial radius of a seed head or pod, m.

We analyze the moment of inertia theoretically and mathematically [14].

If we find from expression (3) $z_2^{\,2} = y_2(2R - y_2)$ and put it in equation (2), we get the following

$$J(y_2) = \frac{\pi}{4} y_2^{\,2}(2R - y_2)^2. \text{ (4)}$$

Substituting the expression (4) into the expression (3.24), we get the following equation

$$\frac{E\frac{\pi}{4} y_2^{\,2}(2R - y_2)^2 d^2 x_2}{dy_2^{\,2}} = F_{эл} y_2. \text{ (5)}$$

Solving the expression (5) $\frac{d^2 x_2}{dy_2^{\,2}}$ with respect to , we get the following

$$\frac{d^2 x_2}{dy_2^{\,2}} = \frac{4F_{эл}}{\pi E y_2 (2R - y_2)^2}. \text{ (6)}$$

Integrating expression (6) once, we get the following equation

$$\frac{dx_2}{dy_2} = \frac{4F_{эл}}{\pi E} \int \frac{dy_2}{y_2(2R - y_2)^2} + C \text{ (7)}$$

or

$$\frac{dx_2}{dy_2} = \frac{F_{эл}}{\pi E}\left[\frac{1}{R^2} \ln \frac{2R - y_2}{y_2} - \frac{2}{R(2R - y_2)}\right] + C. \text{ (8)}$$

(8) is equivalent to the following in the expression

$$x_2 = \frac{F_{эл}}{\pi E}\left[\frac{1}{R^2}\int \ln\frac{2R-y_2}{y_2}dy_2 - \frac{2}{R}\int\frac{dy_2}{2R-y_2}\right] + Cy_2 + D. \quad (9)$$

Based on the initial conditions, C and D are constant, we determine their value according to the following conditions:

$$y_2 = R,\ \frac{dx_2}{dy_2} = 0 \text{ va } x_2 = 0.$$

$\frac{dx_2}{dy_2} = 0$ va $y_2 = R$ we find the value of from the expression (8) based on the conditions

$$C = \frac{2F_{эл}}{\pi E R^2}. \quad (10)$$

After calculating the definite integrals in expression (9), if we put the value of S in expression (10) into expression (9), we get the following

$$x_2 = \frac{F_{эл}}{\pi E R}\left[2 - \frac{2R-y_2}{R}\ln\frac{2R-y_2}{R} - \frac{y_2}{R}\ln\frac{y_2}{R} + 2\ln\frac{2R-y_2}{R}\right] + \left(\frac{2F_{эл}}{\pi E R^2}\right)y_2 + D. \quad (11)$$

$x_2 = 0$ va $y_2 = R$ using the conditions, we determine D the value of from the expression (11).

$$D = -\frac{4F_{эл}}{\pi E R}. \quad (12)$$

Substituting this expression into expression (11), we get the following

$$x_2 = \frac{F_{эл}}{\pi E R}\left[2 - \frac{2R-y_2}{R}\ln\frac{2R-y_2}{R} - \frac{y_2}{R}\ln\frac{y_2}{R} + 2\ln\frac{2R-y_2}{R}\right] + \left(\frac{2F_{эл}}{\pi E R^2}\right)y_2 - \frac{4F_{эл}}{\pi E R}. \quad (13)$$

If the maximum impact F_T force used by the harvesters to separate the seeds of agricultural crops from the ears and pods is used to compress the pods only in width, that is, if $x_2=x_{2max}$ va $y_2=0$ (13) becomes the following expression

$$x_{2max} = -\frac{2F_{эл}}{\pi E R}. \quad (14)$$

Solving the expression (14) with respect to F_{el} and using the fact that $F_T = -F_{el}$ we get the following expression

$$F_T = -F_{эл} = \frac{\pi E R}{2}x_{2max}. \quad (15)$$

Maximum deformation of seed heads or pods

x_{2max}=0,0018 m, the average midal radius R = 0,0045 m and the calculated value of the modulus of E =0,62 MPa in the expression (15), separating the seeds of agricultural crops from the ears and pods we find that the maximum value of the impact force required to obtain F_T = 7,9 N.

Summary

In order to ensure the separation of the seeds of agricultural crops from the ears and pods in the proposed device at the level of agrotechnical requirements, the value of the impact force should not exceed 7.9 N. An increase in the value of the impact force from this indicator leads to an increase in

the level of their damage during the technological process of separating the seeds from their heads and pods.

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