

EVALUATION OF GRAIN SHELLING EFFICIENCY BY ROTOR-TYPE MACHINES

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Grain processing for the purpose of manufacturing products and compound feed is one of the main directions of the country's economic development. The grain prepared for the production of products and compound feed must meet the requirements that make it necessary to obtain quality compound feed, groats, flour and other products. Grain processing is the most important component of the country's agricultural sector, as it provides the consumer market with the necessary raw material. The grain processing industry in the country reaches a significant volume and has prospects for development and increased productivity. The processing of wheat, which contains about 80% of endosperm, appears to be the most important and significant. The efficiency of technological processes of grain preparation in the production of compound feed, groats, flour and other products depends on energy consumption. One of the most important operations of grain preparation for processing is the process of its dehulling. The choice of a rational method for the most effective dehulling process, i.e. the separation of the grain sheaths from the core can be carried out based on taking into account the mechanical properties of the grain and the features of the adopted technological operations. Taking into account the characteristics of the destruction of strength, stresses and friction and properties of viscosity, microhardness and stress relaxation of anisotropic structural grain systems during the organization of the process with the establishment of minimum energy consumption for the implementation of the peeling process is of great practical importance. The optimal mode of control of the peeling process is connected with the choice of kinematics and dynamics of the working body of the machine.

Key words: *grain, mode, process, husking, processing.*

PROBLEM

To evaluate the efficiency of the peeling process, the analysis of the indicators of the ultimate force load of the grain, which determines the efficiency of the separation of the covering shells during peeling with minimal damage to the kernel and its components, appears to be an urgent task [1,2,4].

ANALYSIS OF THE LATEST RESEARCH

The method of assessing the physical characteristics of grain crops is divided into direct and indirect. Direct methods involve evaluation taking into account the final result. Indirect methods are indicators of other characteristics [2,3,4], they depend on culture and intended use. It should be noted that the reliability of the assessment is observed during direct methods, and for indirect assessments it is approximately close. However, the research of different authors led to a different assessment of the correlation between indicators in structural-mechanical and other properties [1,3,4]. At the same time, studies conducted by various scientists indicate the complex dependence of each of the indicators on a number of additional factors and the type of grain that influence the peeling process. The process of processing the surface of the grain and its husking is the most important operation at the beginning of the wheat processing chain. In the case of carrying out the husking process with high performance and compliance with all requirements, a guarantee of receiving qualitatively prepared grain is achieved, that is, we receive clean, processed grain. The peeling process is accompanied by the removal of a significant amount of impurities, and its quality preserves nutrients. Peeling can be carried out either dry or wet, taking into account machines and equipment in the adopted technological scheme. For operations in the first method, machines are used with a working body in the form of a beater, which is installed on steel or abrasive rollers. As an alternative, the process of wet peeling is used, this treatment is the basis for a significant reduction in the consumption of liquid waste. The husk of the grain is resistant to abrasion, so it is crushed worse than the endosperm, and the greater the difference in their strength properties, the greater the probability that they will be crushed further. Hulled grain occupies a larger volume and is characterized by a lower density, compared to unhulled. The ratio of shelled and unshelled grains fluctuates and changes as a result of factors:

- Differences depending on the variety;
 - Yield of 1000 grains - variation within 55-75%, compared to the weight of shelled grains;
 - Grain moisture;
 - Machines used (different machines, and the output depends on the settings and the skill of the operator).
- Studies have shown that the microhardness of flour decreases with increasing humidity and the duration of dehumidification up to 6 hours.

Studies have proven that the physical and mechanical properties of durum wheat grains and their tissues that form the shell, under different moisture regimes, prove that the microhardness of the endosperm part at a moisture content of 9-11% is twice as much as the microhardness of the durum wheat husk, while for soft, this indicator is almost the same. For humidity 17...20% and 25%, endosperm humidity, the microhardness is the same, and when the temperature drops to the level of 4°C, the microhardness increased and became more brittle, which is undesirable for peeling [3,4,6].

RESEARCH RESULTS

In order to achieve high efficiency and operational control of the process of separation of the floral film of grain at the preparatory stage in laboratory conditions, it is necessary to conduct an analysis with an assessment of the deformation properties of the processing layer and with the use of machines that allow choosing processing modes in the active zone of the husking machine with high probability. Taking into account the data on the strength of the grain to break and shear, it is necessary to choose the final forces acting on the grain shell, which is necessary to ensure highly efficient separation of the grain, eliminating its destruction. Because the frictional properties of the grain are known, it is relevant to determine the pressure between the grains and the pressure at the point of contact of the grains with each other. Then, an important element of the process of carrying out an intensive separation of covering shells is to take into account the nature of deformations and strength characteristics of the covering shells using equipment that provides the possibility of forecasting the process carried out in the working area of the machine [6,8,9,11]. Experimental studies have proven that the optimum pressure between the grains, which provides the maximum indicators from the sum of all types of friction that are formed in the working area of the machine as a result of the formation of normal and tangential stress, which is necessary for the effective separation of shells in a rotary machine, can be realized due to formation of the optimal ratio between the carrying capacity of the rotor Q_T and the actual performance indicator Q_m . It was established that such a ratio is characterized by the dependence:

$$Q_T = K_e Q_m \quad (1)$$

where K_e is the experimental coefficient (2.4 ... 2.8)

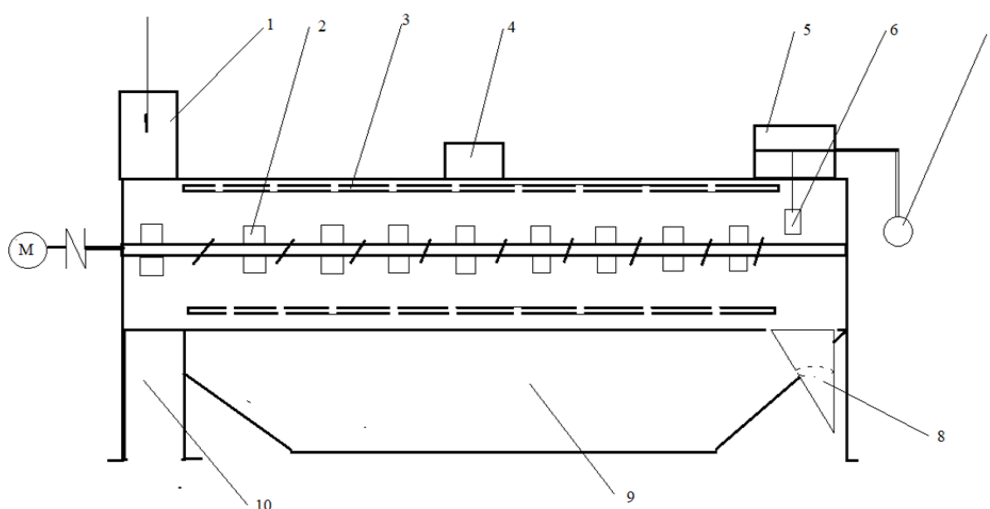


Fig. 1. Functional diagram of the machine: 1 - feeder; 2 - shoulder blade; 3 - sieve; 4 - aspiration nozzle; 5 - outlet pipe; 6 - valve; 7 - counterweight; 8 - reversing valve; 9 - collection; 10 - bed.

Average tensile strength indicators are 80 N for wheat and 97 N for barley. After 40 blows on the grain, micro cracks appeared in the volume of 30% of the grain, but without their complete destruction. That is, during the tests, the speed of the rotor blade was within 15 m/s, while the amount of crushed grain was up to 2.0%. The blades of the rotor, which had a width of up to 0.04 m of the blade, ensured the occurrence of the coefficient of axial movement of the grain K_p up to 0.85, while it was found that the coefficient K_p 0.85 corresponds most closely to the peeling process. As a result of the analysis of the location of the vanes, it was concluded that the arrangement in two circular rows of transfer vanes and one row of vanes, which is the most rational in case of their deviation, can be determined by the ratio:

$$(ZT - Z_o) / (ZT + Z_o) = 1/3 \quad (2)$$

CONCLUSIONS

The relationship between the load carrying capacity of the rotor and the indicator of actual productivity is established. Arrangement in two circular rows of transfer vanes and one row of vanes, which, taking into account the deviations, is the most effective.

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ОЦІНКА ЕФЕКТИВНОСТІ ЛУЩЕННЯ ЗЕРНА МАШИНАМИ РОТОРНОГО ТИПУ

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Переробка зерна з метою виготовлення продуктів та комбікормів є одним з основних напрямків економічного розвитку країни. Підготовлене для виготовлення продуктів та комбікормів зерно, має відповідати вимогам, що роблять умову для отримання якісних комбікормів, крупи, борошна та інших продуктів. Переробка зерна є найбільш вагомою складовою аграрного сектору країни, оскільки забезпечує споживчий ринок необхідною сировиною.

Зернопереробна промисловість в країні досягає значного обсягу та має перспективи розвитку та збільшення продуктивності. Найбільш вагомою, значною виглядає переробка пшениці, яка містить біля 80% ендосперму. Ефективність технологічних процесів підготовки зерна у виробництві комбікормів, крупи, борошна та інших продуктах залежить від енерговитрат. Однією з важливіших операцій підготовки зерна до переробки, є процес його лушення. Вибір раціонального способу для найбільш ефективного процесу лушення, тобто відокремлення оболонки зерна від ядра може здійснюватися на основі врахування механічних властивостей зерна та особливостей прийнятих технологічних операцій. Врахування особливостей руйнування міцності, напружень і тертя і властивостей в'язкості мікротвердості та релаксації напружень анізотропних структурних зернових систем під час організації процесу з встановленням мінімальних енерговитрат на здійснення процесу лушення має велике практичне значення. Оптимальний режим керування процесом лушення пов'язано з вибором кінематики і динаміки робочого органу машини.

Ключові слова: *зерно, режим, процес, лушення, переробка.*