UDC 636.085.55.4
DOI 10.37000/abbsl.2024.110.27

PROCESS ANALYSIS OF GRAIN HULLING PROCESS

I. Dudarev, S. Uminsky, I. Moskalyuk, **N.** Maslych
Odesa State Agrarian University

Cereals are an important source of energy and contain almost all substances necessary for the normal functioning of the human body, animals and birds. The anatomical structure of the grain has an outer shell that can be removed from the surface without destroying the starch core in many technological processes. One of the ways to improve the quality of the final product is to actively treat the surface of the wheat grain to remove the husks during its preparation for grinding. For this, peeling machines of various designs, shelling machines and machines with friction rotary knives are used. The grain is processed under the influence of impact and friction pulses in the working area of the machine, with different abrasive properties of the grain surface, external frictional forces are applied to the grain from the sides of the beater, which arise when the layers are moved along the surface of the beater. Grain is used for the production of starch, molasses and alcohol, and processed grain products include flour, pasta, cereals, bread and animal feed.Cereals are characterized by the fact that they are the main source of easily digestible carbohydrates, the main energy component of food. Bread made from wheat flour weighing 500 g, and which is made from flour of the highest grade, provides about 64% of the daily need for essential acids. The quality of the final product depends significantly on the grain preparation and processing processes. Peeling machines are used as one of the main machines for this. The transport movement of grain in the machine determines the time the grain stays in the working zone, which is achieved by placing different shaped bulls at an angle to the rotor axis, equipping the working zone with races, placing the roller at an angle to the horizontal plane and changing the rotation speed. The main disadvantages of such machines are the low efficiency of the peeling process and uneven surface treatment of individual grains in the cut state.

Key words*: grain, shells, friction, destruction, peeling.*

PROBLEM

The importance and necessity of removing flower, fruit and seed shells from grain (raw materials for cereals, compound feed, flour) is determined by the requirements for obtaining a product that meets modern quality standards. At compound fodder, flour and grain mills, technological preparation and surface treatment is carried out with the help of peeling machines, which are part of the technological production line.

ANALYSIS OF THE LATEST RESEARCH

Analysis of existing plans for preparing grain for processing allows us to conclude that the number and location of husking machines is not clearly defined today. This is due to insufficient efficiency of husking machines when husking grain and high specific energy intensity of the husking process [1,3,4].
The scheme of the technological process of grinding rye grain into flour is similar to the scheme of wheat grinding. Grain husking is carried out by different machines:
- peeling machines: work on the principle of repeated impact; - bull machines: the grain is thrown with great force onto the working surface of the rolling machine, where the shell is removed;
- peeling stands or drum machines that work on the principle of compression and friction. In this type of machine, the kernel is first compressed between two working surfaces (fixed and movable), which leads to the removal of the flower sheath;
- This means that the core repeatedly hits the abrasive disc rotating at high speed, causing friction between the core and the surface of the disc;
The use of certain types of machines is associated not only with the technical difficulties of the operation, but also with the need to take into account the physical characteristics and anatomy of the nucleus. For example, impact hulling equipment is suitable only for hulling barley and oats.
During grain processing in the working area of the husking machine, there are changes in the structural and mechanical parameters of the grain:
- hardness and strength decrease;

- resistance during grain grinding and energy consumption for grinding decreases;
- there is an active penetration of moisture into the internal structural parts of the grain, which causes a reduction in the time of soaking the grain and the process of its dehumidification by almost two times compared to untreated grain, and the quality of the flour at the same time acquires improved indicators [2,3].

The principle of operation and design of the machine for the surface treatment of dry and wet barley grains during their processing into groats and fodder showed the possibility of using a machine with knives of continuous friction [1,4].

The strength of the hull when loaded along the longitudinal axis of the barley grain is 1.44...2 times higher than along the transverse axis. Along the transverse axis, it is 2.06 times higher than along the longitudinal axis. This is explained by the interweaving of three fibrous layers of the cortex and tubular layers in the transverse axis. The seed coat, which has a more uniform structure, is attached to the inner parts of the grain mainly by gluing, which is a necessary condition for their separation [2,4]. Since the technical task of the peeling process is to separate the integument, change data is necessary to show parameters of the preparation and the peeling process.

RESEARCH RESULTS

The functional and parametric scheme of the grain hulling process provides an opportunity to analyze the hulling process in the hulling machine (Fig. 1), and a preliminary study of the movement of the grain made it possible to identify the following three zones that differ in the steady state along the length of the hulling rotor of the machine:

I - distribution;
II - preparation;
III - dense peeling and unloading.

During the transportation of grain from the loading hole to unloading in the zone, an increase in pressure and the compaction coefficient between grains is observed, this leads to the transition of grain into a flow with a high-density structure, instead of a split one. And its value is determined by the speed in the field of gravity and the action of centrifugal forces in contact with the rotor blades, which move the product from the base of the rotor to the surface zone, where compaction occurs. The value of compaction and its thickness in the outer compacted layer increase in the transition zone, reaching their maximum values in the zone of intense peeling. In the first zone, the filling factor becomes 0.1-0.3, in the preparation zone it is 0.6-0.8 and reaches a maximum value close to 1 in the unloading zone [5,6,9]. The state of pressure between the grains changes from the minimum in the preparation zone of the machine, and in the unloading zone to the value at which the texture of the coating is partially separated. The peeling process due to the action and occurrence of internal friction in the elastic- stressed grain layer, is determined by the system of micro-contacts of grain surfaces during their relative movement, and the appearance of instantaneous local pressure in the grain shells at the contact areas under the action of the pressure force causes a change in the shape of the shells at the stage of active elastic deformations, and during the increase of stresses, both micro and and macro destruction in the structural connections with the grain core in areas that have the lowest strength. Due to the occurrence of unforeseeable counter-contacts for different areas of the surface of the grain, with each other and with the working bodies of the machine, their surface loads are formed, this happens with repeated repetition, which is the basis for the occurrence of irreversible processes of micro-cutting and destruction of the shell tissues.

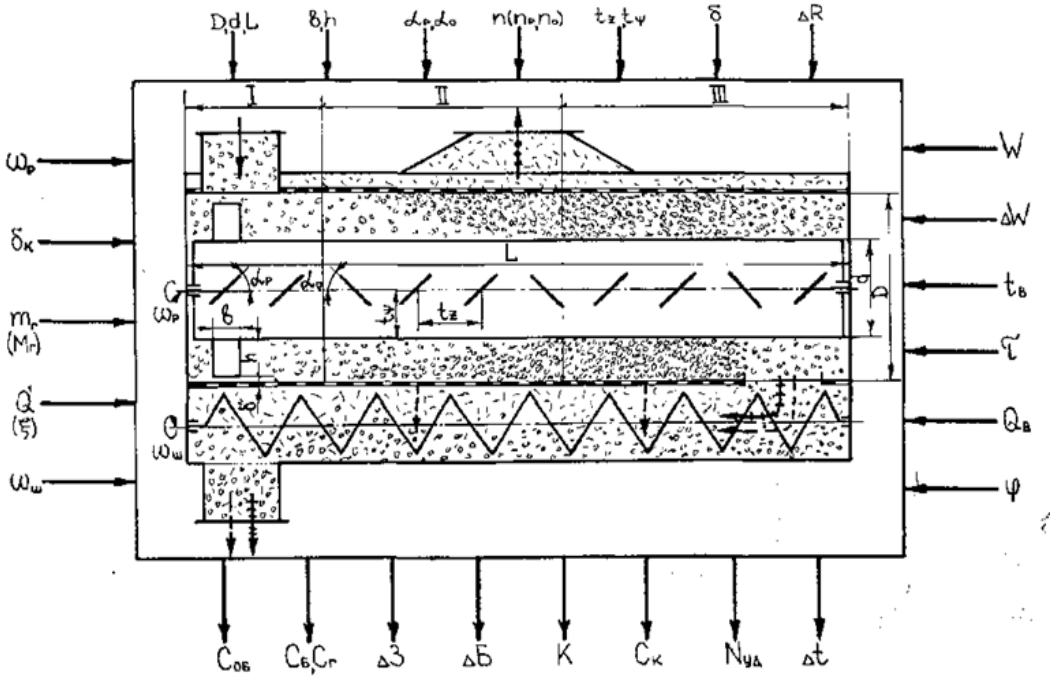

Fig. 1. Functional and parametric diagram of grain hulling.

That is, the grain husking process can be imagined as a wear system that occurs during the sliding of moving grains in their relative motion and the effect of external friction on the structural elements of the husking machine. A necessary condition for the process of shell separation is the development of normal forces, which carry out the preparatory phase of grain processing due to the force closing of the shells in the touching zones, and the occurrence of tangential stress. For such a system of contacts between grains, and taking into account the design of the machine to achieve the maximum peeling effect, a necessary condition is the formation shifts in the tangential direction, this is achieved by installing movable and immovable destructive and braking surfaces in the design of the machine and strengthening the effect of movement and mixing of grain layers in its working part, as well as the formation of devices for activating relative shifts in grain flows, as well as individual grains [7,10].

CONCLUSIONS

The analysis of the considered forces made it possible to establish that their joint action creates conditions for directed radial-axial movement of grain and determines the process of processing grain with the working surfaces of the husking blades.

REFERENCES

1. Dudarev I., Agrarian Bulletin of the Black Sea Region. Vol. 80. 2016 Processing and friction properties of grain Odesa State Agrarian University p. 137-144.
2. Dudarev I.I. Grain moisture / Dudarev I.I. // Agrarian Bulletin of the Black Sea Coast. Collection of scientific works. Technical sciences. - Odesa: 2014 Vol. 74. - P. 129-132.
3. Dudarev I.I. Hulling of moistened grain / I.I. Dudarev. // Agrarian Bulletin of the Black Sea Coast. Collection of scientific works. Technical sciences. - Odesa: 2015 Vol. 78. - P. 141-14
4.I. Dudarev, S. Umynskyi. Evaluation of the performance of a friction blade machine for post-harvest processing of grain of cereal crops. Abstracts of the reports of the 1st International scientific and practical conference of the NPP and young scientists "Actual aspects of the development of science and education". Odesa 2021. April 13-14. P.31
5. I.I. Dudarev, S. M. Uminsky Expansion of technological capabilities of diagnostics of finishing thread grinding operations, International eurasian agriculture and natural sciences congress ISBN978-605-69010-2-7 October 30-31, 2020 P.514-521.

6. T. Czaja, A. Sobota, R. Szostak, Quantification of Ash and Moisture in Wheat Flour by Raman Spectroscopy. Foods, 9(3), 2020: 280. https://doi.org/10.3390/foods9030280
7.Alexey Yakimov, Isak Karabegovic, Sergey Uminsky**,** Viktor Strelbitskyi, Julia Shichireva.
Stability of the Quality Parameters for the Surface Layer of Parts During Circular Grinding Operations..
2-nd Grabchenko's International Conference on Advanced Manufacturing Processes Interpartner-2020. Lecture Notes in Mechanical Engineering. Springer, Cham. P. 464 – 476. SCOPUS Print ISBN: 978-3-030-68013-8 , Electronic ISBN: 978-3-030-68014-5,https://www.springer.com/gp/book/9783030680138
8. Fang Q., Hanna MA, Haque E., Spillman CK Neural network modeling of energy requirements for wheat size reduction, Transaction of the ASAE 2000; 43 (4) 947-952.
9. Voicu G., Casandroiu T., C., Tudosie EM, Voicu P. Experimental study of the physical characteristics of products obtained from grinding wheat, Current tasks in agricultural technology 2010; Opatija, Croatian, 399-410.
10. Larshin, V., Babiychuk, O., Lysyi, O., Uminsky, S. Discontinuous Generating Gear Grinding Optimization. Lecture Notes in Mechanical Engineering, 2022, pp. 263–272. V. Ivanov et al. (Eds.): DSMIE 2022, LNME, pp. 263–272, 2022. https://doi.org/10.1007/978-3-031-06025-0_26 https://www.scopus.com/authid/detail.uri?authorId=57217107788

АНАЛІЗ ПРОЦЕСУ ПРОЦЕССУ ЛУЩЕННЯ ЗЕРНА

І. Дударев, С. Уминський ,І.Москалюк, Н. Маслич
Одеський державний аграрний університет

Зернові є важливим джерелом енергії і містять майже всі речовини, необхідні для нормального функціонування організму людини, тварин і птиці. Анатомічна будова зерна має зовнішню оболонку, яка може бути видалена з поверхні без руйнування крохмального ядра в багатьох технологічних процесах. Одним із способів підвищення якості кінцевого продукту є активна обробка поверхні зерна пшениці для видалення оболонок при її підготовки до помелу. Для цього використовують лущильні машини різних конструкцій, щитобивальні машини та машини з фрикційними ротаційними ножами. Зерно обробляється під впливом імпульсів удару і тертя в робочій зоні машини, з різними абразивними властивостями поверхні зерна, до зерна прикладаються зовнішні сили тертя з боків бітера, які виникають при переміщенні шарів по поверхні бітера. Зерно використовується для виробництва крохмалю, меляси і спирту, а продукти переробки зерна включають борошно, макаронні вироби, крупи, хліб і комбікорми.
Злаки, характерізуються тім, що вони є основним джерелом легкозасвоюваних вуглеводів, головного енергетичного компонента їжі. Хліб виготовлений з пшеничного борошна вагою 500 г, та який виготовлено з борошна вищого ґатунку, забезпечує близько 64% добової потреби в незамінних кислотах. Якість кінцевої продукції суттєво залежить від процесів підготовки та переробки зерна. Однією з основних машин для цього використовують лущильні машини. Транспортний рух зерна в машині визначає час перебування зерна в робочій зоні, що досягається розміщенням бичів різної форми під кутом до осі ротора, обладнанням робочої зони перегонами, розміщенням вальця під кутом до горизонтальної площини і зміною швидкості обертання. Основними недоліками таких машин є низька ефективність процесу лущення та нерівномірність обробки поверхні окремих зерен у зрізаному стані.

Ключові слова: *зерно, оболонки, тертя, руйнування, лущення.*