7. Izmenenie temperature zerna pru hranenii v skladah [Elektronny`j resurs]. Rezhy`m dostupu: // https://www.activestudy.info/izmenenie-temperatury-zerna-pri-xranenii-v-skladax
8. Osobluvosti zberigannya zerna v zumovui period, [Elektronny`j resurs]. Rezhy`m dostupu: // https://www.cherk-consumer.gov.ua/novyny/4111-osoblyvosti-zberihannia-zerna-v-zymovyi-period
9. Chunnuku scho vuznachaut truvalist zberigannya zerna, [Elektronny`j resurs]. Rezhy`m dostupu: // https://agroexpert.ua/chynnyky-shcho-vyznachaiut-tryvalist-zberihannia-zerna
10. Zberigannya zerna, [Elektronny`j resurs]. Rezhy`m dostupu: // https://gcs.com.ua/ua/zerno

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ДОСЛІДЖЕННЯ ТЕРМОМЕТРІЇ ЗЕРНА ПІД ЧАС ЗБЕРІГАННЯ

Анотація

Термометрія зерна – це процес вимірювання температури зернових мас під час їх зберігання. Ключові аспекти, які підкреслюють важливість контролю температури для забезпечення якісного збереження: Запобігання самозайманню: запобігання росту грибків і бактерій, підтримання стабільності вологи, зменшення втрати поживних речовин, збереження кольору та смаку, мінімізація росту комах і шкідників. Загалом, контроль температури при зберіганні зерна є важливою стратегією для підтримки якості продукції, зменшення втрат і забезпечення безпеки зберігання. Сучасні технології моніторингу та автоматизації дозволяють ефективно контролювати температуру в сховищах. Температура зерна в сховищі може залежати від ряду погодних умов і факторів. Основні фактори, які можуть впливати на температуру зерна: температура повітря, вологість повітря, сонячне тепло, технічне оснащення сховищ, природні умови зерна, денні та нічні коливання температури. Значний вплив на температуру зерна має температура повітря навколо сховища. Взимку холодна погода може призвести до зниження температури зернових мас, а влітку висока температура може сприяти її підвищенню. Важлива також вологість повітря. Висока вологість може призвести до конденсації вологи в сховищі, що, у свою чергу, може підвищити температуру зерна через хімічні процеси, такі як розкладання. Сонячне тепло може прямо чи опосередковано впливати на температуру зерна, особливо якщо сховище знаходиться під прямими сонячними променями. Ефективність зберігання та технічне обладнання, таке як системи вентиляції та кондиціонування повітря, можуть впливати на розподіл та збереження тепла в сховищі. Саме зерно може впливати на свою температуру через хімічні та біологічні процеси, такі як дихання та виділення тепла. Денні та нічні коливання температури можуть сприяти розподілу тепла в сховищі. Нами було проведено дослідження зміни температури зерна під час зберігання на підприємстві в Одеській області та встановлено вплив різних факторів на зміну температури зерна.

Ключові слова: температура зерна, термометрія, зберігання зерна, термосуспензії, термосенсори.

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DEVELOPMENT OF HIGHLY EFFICIENT TECHNOLOGICAL EQUIPMENT

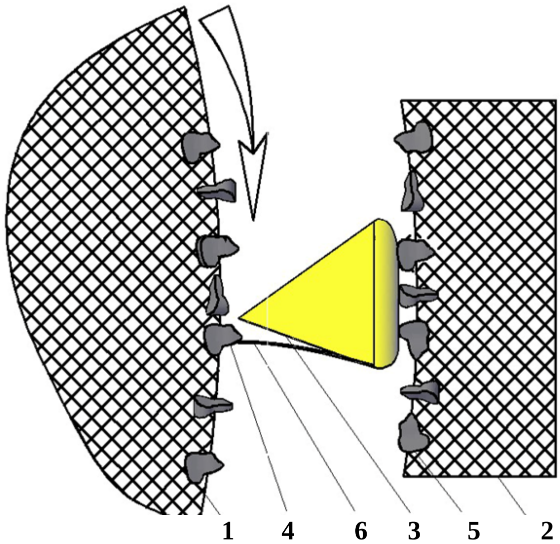
Annotation

The article discusses the problems associated with processing buckwheat on roller deck machines and reducing the amount of crushed kernel. Recently, there has been a tendency to increase the number of processed fractions of buckwheat grain, which significantly improves the quality of the output product. At the same time, this requires more precise adjustment to the working gaps and obtaining the correct shape of the working area (crescent-shaped when processing buckwheat) between the abrasive roller and the deck. The designs of roller deck machines used in the cereal industry and their installation mechanisms are analyzed. The mechanisms used for installing the deck on rolling deck machines do not allow one to accurately set the shape of the working gap and its dimensions. A more advanced mechanism for removing the deck from the abrasive roller and a mechanism for installing the deck on a wedge shape between the deck and the abrasive roller (usually used *when processing millet or sorghum) have been proposed. The calculations of working gaps confirm the correct choice of geometric parameters of the abrasive roller, deck and installation mechanisms. The dependences of the minimum working gap on the magnitude of the parallel movement of the deck are determined. The dependences of the difference in working gaps between the deck and the abrasive roller when changing the structural height of the deck were also found. It is shown that as the deck height is reduced by half, the difference between the maximum working gap and the minimum decreases by four times. This significantly affects the shape of the processing zone and the working dimensions in the active zones of buckwheat peeling. Reducing the deck height under production conditions leads to an increase in the amount of broken grain, due to an increase in the number of grains passes through the hulling machines. Based on the obtained calculation data, the roller deck machine was modernized, and in fact, a new model was developed in which the process flow is stabilized, the conditions for feeding grain into the working area are improved, and the working gaps are adjusted optimally in two active zones of buckwheat grain processing. The design of the roller deck machine allows you to select the husks from the kernel and send them to waste bins.*

Key words: roller deck machine, peeling, buckwheat, millet.

Introduction

When processing buckwheat on roller deck machines, a crescent-shaped working gap is installed between the deck and the abrasive drum (Fig. 1), which allows you to have two zones of active influence on the buckwheat grain, mainly at the beginning and at the end of the working zone. The presence of two zones with the correct adjustment to the working gaps allows you to process buckwheat grain in one pass and reduce the amount of broken grain by eliminating additional passes. From the hopper, the grain, with the help of a feeding device, enters the working gap between the abrasive roller 1 and the abrasive deck 2, as a result of which it is pressed by one of the faces of its tetrahedron to the deck and experiences micro-cutting forces on the shell 6 from the micro-cutters 4 of the roller. The abrasive deck with cutters 5 has a retarding effect on the progress of the grain. The grain continues to slide downwards under the influence of forces from the roller along the working gap. In the middle zone of the deck, where the gap is increased, the buckwheat grain has the opportunity to turn and the next faces with the shell will be exposed to the abrasive action of micro-cutters 4 of the rotating roller. Thus, comprehensive processing of buckwheat grain occurs in the upper and lower working zones of the machine and release of the kernel 3. Taking into account the large variation in the geometric dimensions of buckwheat grain [1, 2], processing is carried out by dividing the grain into several fractions that differ from each other by several tenths of a millimeter [3-5], This requires high-precision processing equipment with precision adjustment mechanisms.



***1** - the abrasive roller, **2** - the abrasive deck, **3** - the kernel, **4** - the micro-cutters, **5** - the abrasive deck with cutters, **6** - the shell*

Fig. 1. Scheme of buckwheat peeling.

Results of the study and their discussion

Let's consider the design diagrams of rolling deck machines.

In Fig. 2a shows a diagram of the installation mechanism used in the rolling deck machine model SVU-2. The machine includes: a hopper 1 with a feeding device, an abrasive roller 2, a deck 3 mounted on a rod 4, and on a support 8. To press the deck 3 to the roller 2, a nut 5 with a spherical end interacts with the thread of the rod 4. To fix the working position of the nut 5, a lock nut 6 is used. The position of the deck in space is ensured by moving the right side of the deck in the support 8 using a screw mechanism 7 with a steering wheel. Before putting the roller deck machine into operation, the deck 3 is ground to the abrasive roller 2. To do this, the deck 3 is adjusted using two screw mechanisms 5 and 7 to the roller 2 and, with the abrasive roller rotating, part of the deck surface is removed. Then the deck 3 is moved parallel to the abrasive roller 2. However, it is difficult to perform this operation using two screw mechanisms; certain skills of the operating personnel and additional adjustment are required.

In Figure 2b shows a diagram of the installation mechanism of a rolling deck machine model ZMSH. The machine includes a hopper 1 with a feeding device, and an abrasive roller 2 installed underneath it made of natural sandstone of medium hardness. The deck 3, on both sides, is suspended on two pairs of rods 4 and 5, which allows it to move along a circular arc.
To control the position of the deck relative to the drum, the left and right levers 4 are connected by threaded rods 6, with gear wheels 7, which have internal threads and are installed without the possibility of axial movement in the frame 8. The steering wheel 9 is located on the same shaft with a gear wheel, which, through intermediate gears, connected to gear wheels 7. Rotation of the steering wheel 9 causes all gear wheels to rotate, which in turn leads to the translational movement of rods 6, since they are connected to gear wheels 7 through a thread. Thus, the deck 2 moves relative to the roller 1, thereby increasing or decreasing the working gap.

When adjusting the parallelism of the deck relative to the cylindrical surface of the drum, disconnect the kinematic connection of the gear wheels on one side of

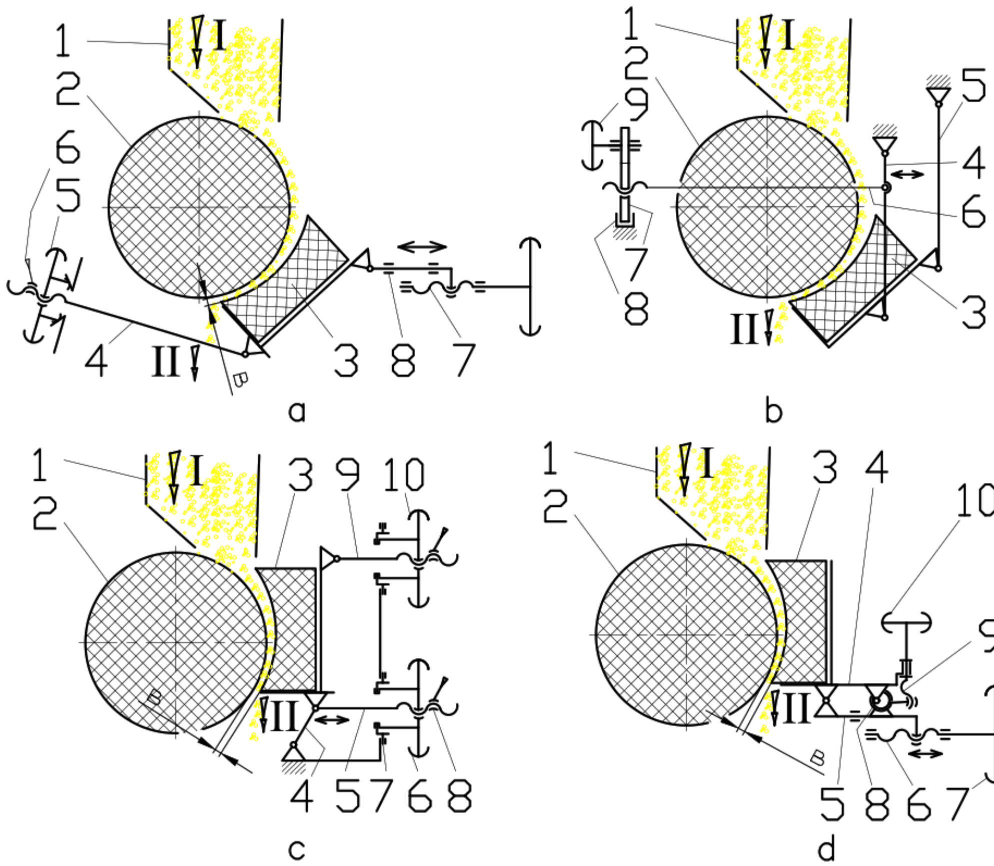


Fig. 2. Schemes of installation mechanisms of rolling deck machines.

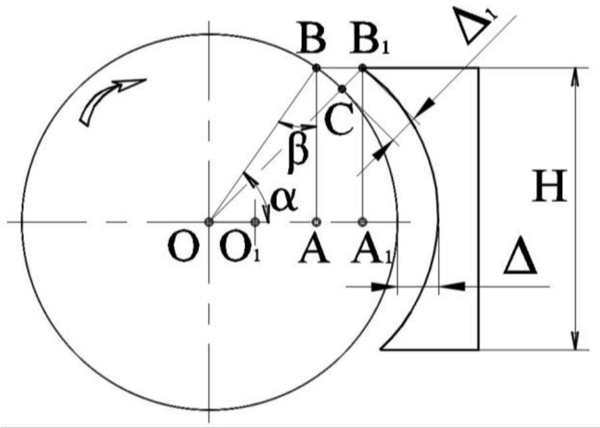


Fig. 3. Scheme of movement of the deck relative to the abrasive roller.

the deck. On the other side of the machine, rod 6 will begin to move and the deck on this side will be moved from the drum in the desired direction, which will lead to an increase or decrease in the working gap. In this way, it is possible to achieve parallelism between the deck and the roller along the entire length of the roller. A similar operation can be performed on the other side of the machine. A change in parallelism between the deck and the roller occurs for several reasons, the main ones being the uneven supply of the working area of the rolling deck machine due to disturbances in the operation of the feeding mechanism (misalignment of the supply valve, uneven supply of product to a half-empty hopper, etc.) and uneven wear of the roller or deck.

The initial product enters through a material pipeline into a receiving and distribution tank, under which there is a rotary valve, the position of which, when turned manually, determines the productivity of the machine. The grain, coming out in a uniform stream between the lower edge of the inclined wall of the receiving and distribution tank and the plane of the damper, enters the guide pipe, which prevents excessive splashing of the grain and reduces its breakage.

The position of this pipe during operation requires adjustment due to wear of the roller and deck, and a shift in the position of the working area. The grain is drawn into the working area by a rapidly rotating abrasive roller and pressed against the deck, which exerts a braking effect on the grain. Due to the resulting compression and shear forces, the shell of the grain lags behind the core and comes off. When leaving the working area, peeling products enter the collection and removal device and are removed from the machine. Both the considered machine and other similar machines have a number of disadvantages. The main ones are: uneven supply of grain, fight when entering the working area due to incorrect orientation of the grains, difficulty in adjusting the shape of the working area and working size, insufficient accuracy of the installation mechanism due to free play in threaded pairs and hinges, change in operating parameters due to wear (sometimes uneven) of the roller and deck, etc.

According to the diagram presented in Fig. 2c, rolling deck machines of the SGR-400 and SGR-600 models are manufactured. The deck 3, in the designs of these machines, is mounted on articulated arms 4, the position of which is adjusted using a screw 5 with a nut 6 installed in the hinges 7 of the frame. The position of the lower part of the deck 3 is fixed using a lock nut 8.

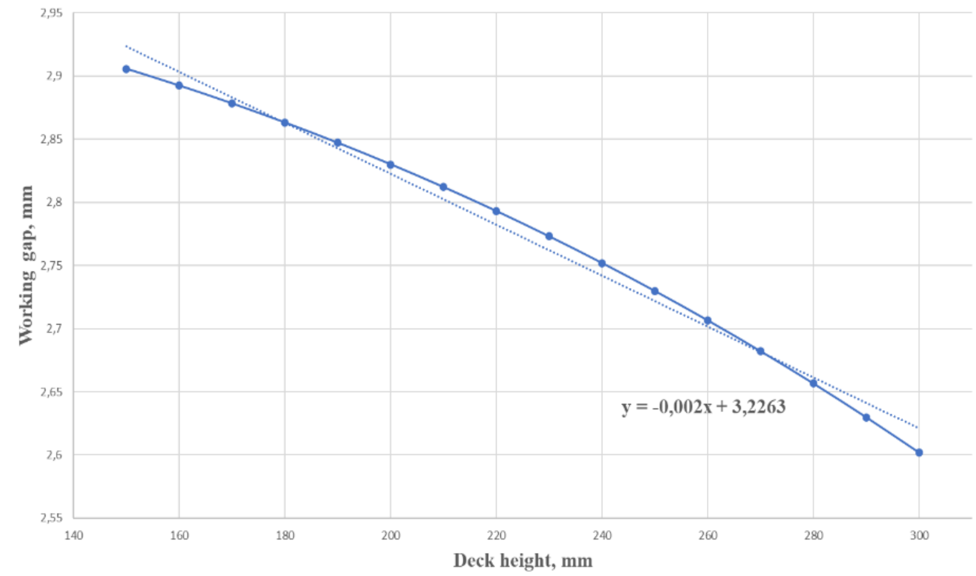


Fig. 4. Dependence of the working gap on the deck height.

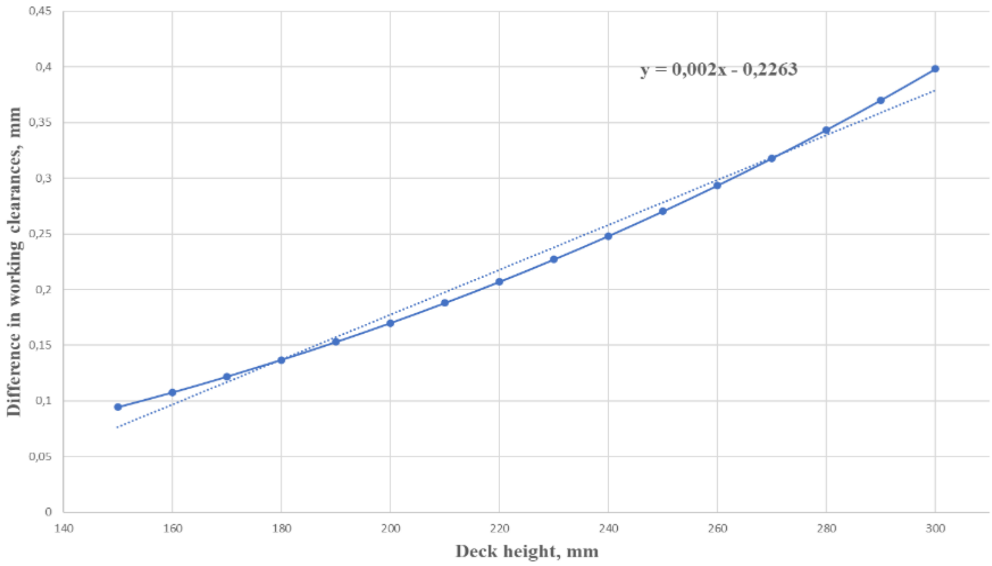


Fig. 5. Dependence of the difference in working clearances on the deck height.

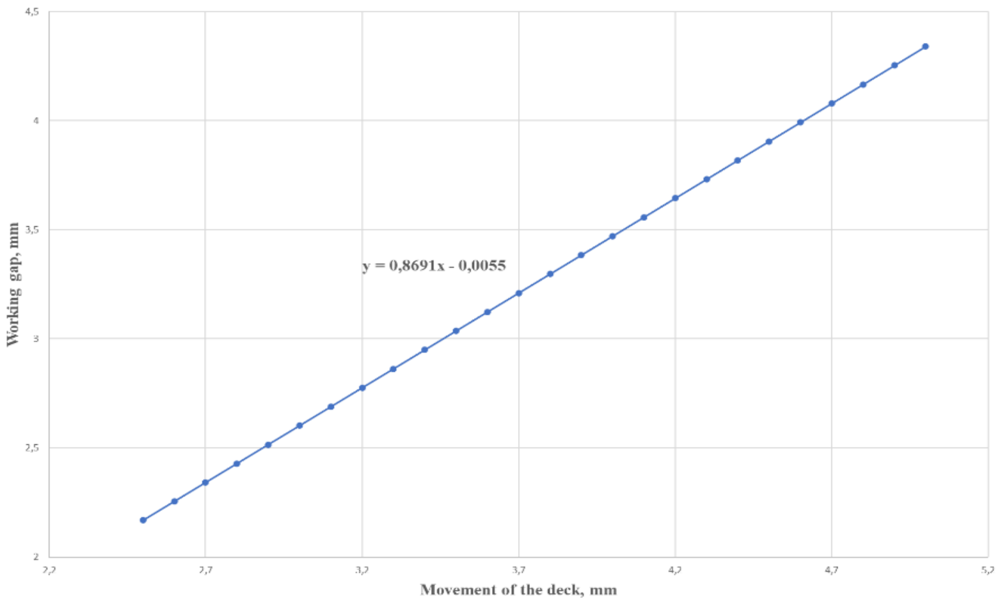


Fig. 6. Dependence of the working gap on the movement of the deck.

The position of the upper part of the deck is adjusted using a similar screw mechanism consisting of a screw 9 and a nut 10. Adjustment of two zones of the deck (upper and lower) allows you to set both a crescent-shaped and wedge-shaped gap between the roller and soundboard.

The disadvantage of the design is the large number of hinges in the installation mechanism, which leads to excessive free movement of the deck. There is also a difficulty in strictly parallel retraction of the deck from the abrasive roller after their joint grinding.

Some manufacturers of technological equipment, as well as technical personnel who service these machines, reduce the height of the deck, which from our point of view is absolutely unacceptable. Let's consider the situation when, after lapping, we move the symmetrically installed deck away from the abrasive roller Ø600 mm by 3 mm (Fig. 3). As follows from the figure, the working gap b1 in the upper working area will be less than the distance to which the deck was set. From the expression Sinα = H/2R we find the value of angle α. Then the angle β will be equal to β = 90° - α. And we determine the distance OB_1 from the center O to the end point of the deck from the expression

$$OB_1 = R + b2 – 2·R·Δ·Cos (β + 90°).$$

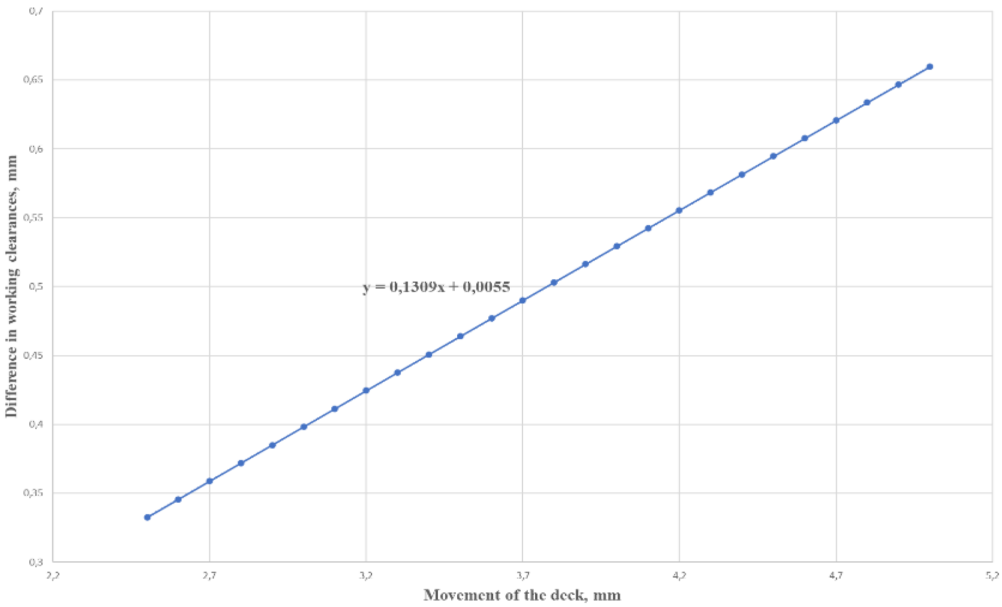


Fig. 7. Dependence of the difference in working clearances on the movement of the deck

Then the working gap $\Delta_1 = OB_1 - R$.

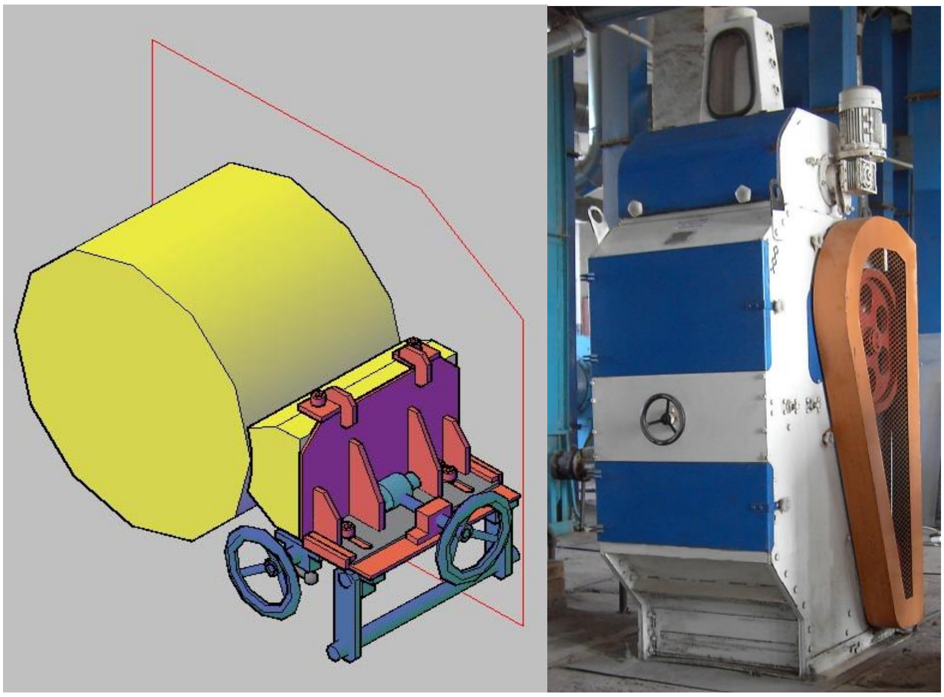
Let's calculate the value of the working gap Δ_1 at different deck heights (Fig. 4). As follows from the resulting graph, the working gap Δ_1 has an almost linear relationship and decreases with increasing deck height. In this example, 0.3 mm. At the same time, the difference between the initial working gap and the gap in the middle part of the deck increases to 0.4 mm, which facilitates the free rotation of the grain after passing through the upper, more cramped working area (Fig. 5). Rotating the grain leads to an increase in the probability of processing the next side of the grain, and as a result to the complete release of the kernel from the shell. This increases the percentage of hulled grain in one pass, which leads to a decrease in the amount of broken grain.

If we consider the dependence of the smallest working gap on the amount of movement of the deck (the gap between the deck and the abrasive roller), then it will be linear (Fig. 6). At the same time, with increasing distance from the deck to the abrasive roller, the difference between the largest distance in the middle part of the deck and the smallest working gap increases, up to 0.65 mm (Fig. 7).

Reducing the deck height during machine operation leads to an asymmetrical arrangement of the upper and lower working areas, due to the deck being based on the bottom edge. This results in an almost wedge-shaped gap and the loss of all the benefits of the crescent-shaped gap setting. The use of a deck of lower height, with its symmetrical location in the horizontal plane (due to spacers), leads to the situation discussed above.

In the modernized version of the machine, the diagram of the installation mechanism has been changed and is shown in Fig. 2d. When processing buckwheat, deck 3 in support 5 moves along rigid guides 8, which makes it possible to maintain parallelism between the surfaces of abrasive roller 2 and deck 3 when the latter is retracted. The deck 3 with the support 5 is installed in the working position from the steering wheel 7 using a screw mechanism 6.

The deck holder is mounted on the support 5 pivotally, through an eccentric, with the ability to adjust the position of the deck using a screw mechanism 9 from the steering wheel 10. That is to obtain a wedge gap, which is necessary when processing millet, it is possible to tilt the deck from the vertical using an eccentric mechanism. In this case, the hinge connections have little effect on the change in the working gap between the abrasive roller and the deck. Installing the deck in rigid parallel guides, with the ability to rotate from a rigid eccentric mechanism, allows you to increase the accuracy of



a b

Fig. 8. Diagram of the deck installation mechanism (a) and general view (b) of the rolling deck machine model SGR-600M

machine settings, while maintaining these requirements throughout the entire life of the machine. The design of the receiving pipe has been changed, in which level sensors are installed that control the operation of the feed roller, which is driven into rotation by an individual electric motor. In addition, purging of peeling products with process air and selection of shells have been introduced. The aesthetics of the machine has been improved by changing the layout of the drive mechanisms. A removable tray is installed for sampling (Fig. 3).

Conclusions

1. The kinematic diagrams of the installation mechanisms of roller-deck machines used in the cereal industry are considered. Their advantages and disadvantages are revealed.

2. Dependences of working gaps on the setting conditions of the installation mechanism were obtained.

3. The design of a rolling deck machine with an improved design of the deck mounting mechanism has been developed.

REFERENS

1. Haponyuk O.I., Soldatenko L.S., Hrosul L.H. i in. Tekhnolohichne obladnannya boroshnomelʹnykh i krupʺyanykh pidpryyemstv, Kherson: Oldi-plyus, 2018, 752.
2. Verstat valʹtsedekovyy S·HR-600 i S·HR-400, Elektronnyy resurs, Rezhym dostupu: https://simo.com.ua/ua/obladnannya/stanok-valcedekoviisgr-600
3. Chevokyn A.A., Melʹnykov E.M., Yzosymov V.P. Povyshenye éffektyvnosty fraktsyonyrovanyya hrechykhy y vyrabotka produktov bystroho pryhotovlenyya na sushchestvuyushchykh hrechezavodakh// Khranenye y pererobka ze-rna, 2002, №14, t.2, 11-14.
4. Dubinina A.A., Popova T.M., Lerent S.O. Analiz khimichnoho skladu hrechanoyi krupy iz hrechky riznykh selektsiy-nykh sortiv// Vostochno-Evropeyskyy zhurnal peredovykh tekhnolohyy, Kharkiv, 2014, 58-61.
5. Panna A.V., Skarlat V.I., Poshtarenko M.H. Doslidzhennya tekhnolohichnykh skhem vyrobnytstva hrechanoyi krupy, Tezy student·sʹkoyi naukovoyi konferentsiyi Mykolayivsʹkyy natsionalʹnyy ahrarnyy universytet, 2017, 25-28.

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РОЗРОБКА ВИСОКОЕФЕКТИВНОГО ТЕХНОЛОГІЧНОГО ОБЛАДНАННЯ

Анотація

У статті розглянуто проблеми, пов'язані з переробкою гречки на вальцедекових верстатах та зменшенням кількості дробленого ядра. Останнім часом намітилася тенденція до збільшення кількості фракцій зерна гречки, що переробляються, що значно покращує якість вихідного продукту. У той же час це вимагає більш точного настроювання на робочі зазори та отримання правильної форми робочої зони (серповидної при переробці гречки) між абразивним вальцем та декою. Проаналізовано конструкції вальцедекових верстатів, що використовуються у круп'яній галузі промисловості, їх настановні механізми. Використовувані механізми установки деки на верстатах вальцедекових не дозволяють точно виставити форму робочого зазору так і його розміри. Запропоновано більш досконалий механізм відведення деки від абразивного вальця, так і механізм встановлення деки на клинову форму між декою та абразивним вальцем (який зазвичай використовується при переробці проса або сорго). Проведені розрахунки робочих проміжків підтверджують правильний вибір геометричних параметрів абразивного вальця, деки та настановних механізмів. Визначено залежність мінімального робочого зазору від величини паралельного переміщення деки. Також знайдено залежності різниці в робочих зазорах між декою та абразивним вальцем при зміні конструктивної висоти деки. Показано, що зі зменшенням висоти деки наполовину різниця між максимальним робочим зазором і мінімальним зменшується в чотири рази. Це суттєво впливає на форму зони обробки та робочі розміри в активних зонах лущення гречки. Зменшення висоти деки у виробничих умовах призводить до збільшення кількості битого зерна, за рахунок збільшення кількості перепусток зерна через лущильні машини. На підставі отриманих розрахункових даних виконано модернізацію вальцедекового верстата, а по суті розроблено нову модель, в якій стабілізується технологічний потік, покращено умови подачі зерна в робочу зону, робочі зазори налаштовуються оптимально у двох активних зонах обробки зерна гречки. Конструкція вальцедекового верстата дозволяє відбирати лушпиння від ядра і відправляти його в бункери для відходів.

Ключові слова: вальцедековий верстат, лущення, гречка, просо.

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