PARAMETERS OF A MOBILE PADDY DRYER

Rakhmankulov Tursunboy Batirali ogli
Teacher of Andijan State Technical Institute Institute,
E-mail: botirali.bekkulov1@gmail.com
Tel:+998932530504

Abstract
The authors in the article describes the results of scientific research aimed at creating a patented new design of a mobile drum device and ensuring an increase in the amount of rice due to high-quality drying paddy by substantiating devices parameters. To determine the kinematic parameters of the movement of the embankmentpaddy in the dryer drum, programs have been developed that plot the trajectory of the center of gravity on the plane, the projection of the center, the projection of the velocity of the center of gravity, the projection of acceleration on the coordinate axes of the section of the embankment paddy in the dryer drum. It is shown that the obtained dimensions determined the geometric dimensions of the drying drum, developed the theoretical basis for creating the operating temperature of the drying agent in the drying drum and a method for determining the specific heat capacity of the paddy. The results of the study can be used in the design of new grain dryers and the expansion of ideas about increasing the number of useful products in grain processing.

Keywords: Mobile drying device, drying drum, grain, paddy, rice, radius of gyration, absolute speed, absolute acceleration, geometric dimensions, technical characteristics.

Introduction

In world practice, special attention is paid to the creation of equipment and technologies that will increase the amount of rice in subsequent processing processes due to high-quality drying of the paddy. Increasing the quantity and decreasing the cost of rice through good drying paddy and the development of compact, energy efficient, easy to use and inexpensive dryers for drying paddy, is one of the most pressing problems in the country and is of great importance for the national economy.

In the world practice, various devices and equipment have been developed to ensure the quality of drying processes for paddy, and they are recommended by the design office for the production of new machines. Research has been carried out on the development of designs of grain dryers, the study of their parameters.

The creation, testing and substantiation of the parameters of the working bodies of grain dryers was considered in the works of a number of scientists.

However, in these studies, the influence of device parameters on the quality of certain types of grain, in particular paddy, has not been sufficiently studied. In connection with this, research aimed at developing and substantiating the parameters of a device for drying a paddy is relevant.

Materials and research methods

The analysis of patent information materials, carried out research works on the development of technologies and techniques that reduce energy consumption for drying paddy and other types of grain.

In research by H.S.Md. Sazzat, N.I. Mohd, A.A. Norashikin and S.P. Mohd [1] provides an energy analysis of a device for drying a paddy used in industry, the drying capacity of which is 22 t / h. The drying performance is high, but only 31.18-37.01% of the energy is used to dry the paddy.

S.Firouzi, M.Rez.Alizadeh and D.Haghtalab [2] have developed a horizontal drum dryer for drying a paddy. The research was carried out at a drying agent temperature of 38-40 ºC, a speed of 0.171 m / s, and the energy consumption and the quality of the dried paddy were studied. According to the data obtained, the specific energy consumption is 5500-17410 kJ / kg and the quality of the dried paddy is high relative to the dried paddy in other devices. However, according to the research results, it was observed that the specific power consumption in the device is relatively high.

Studies by T. Dissanayakea, D. Bandaraa, H. Rathnayakea, B. Thilakarathnea and D. Wijerathneb [3] provide information on a mobile device for drying paddy, which provides drying of a 1 ton paddy with a moisture content of 18-24% at a drying agent speed temperature 60 ° C. According to the results of the experiments, it is shown that the efficiency of the device is 0.18, the heat utilization coefficient is 0.82, and the heat output is 46.83%. According to the research results, it has been observed that the efficiency of the device is relatively low.

From the side of M.S.H. Sarker, M. Nordin Ibrahim, N. Ab. Aziz and P. Mohd. Salleh [4] developed an industrial device for drying the paddy. The device provides drying of the paddy of 15 tons, the research was carried out at a moisture removal of 10.5% and on the quality and quantity of rice obtained from the processing of the dried paddy. - 39 ° C high quality rice was obtained with a large quantity relative to the drying temperature of the paddy 41 - 42 ° C.

M. Beigi, M. Torki-Harchegani and M. Tohidir [5] in their studies studied the process of drying the paddy by the convective method in an experimental device with different modes of parameters. Increasing the temperature and speed of the drying agent shortened the drying time; higher values of the initial moisture content of the paddy led to an increase in the drying time. According to the experimental data obtained, it was determined that at a high temperature value and at a lower value of the speed of the drying agent, the initial moisture content of the paddy, the energy performance of the device was improved. Increasing the temperature increases the drying performance, however, it will cause the rice to crack in the paddy.Thus, the device has not fully solved the problem of high-quality drying of the paddy.

D.Yu.Danilov [6], in his research, developed an energy-saving cassette device for drying wheat on farms. In the study, it was achieved that with a specific energy consumption of 8 ± 2.5 W · h / kg, a drying agent temperature of 60 ± 2.5 ° C, a moisture removal of 5% in one pass is provided in the device.

In the study of A.Zh.Sagindikov [7] a device for drying wheat has been developed, the drying performance has been increased by improving the design and technological parameters. It has been achieved that the drying capacity is 40 kg / h with a specific energy consumption of 3.2 -

3.6 mJ / kg.

In the device for drying grain developed by V. I. Kurdyumov and A. A. Pavlushin [8], the drying quality is improved and the metal consumption is reduced. However, the device has a complex design.

In the device developed by the research of M.M. Abdyushev [9], drying performance is increased and fire safety is ensured.

NV Tsuglenok, S.K. Manasyan and N.V. Demskiy [10] conducted studies to improve the quality of grain drying and reduce material costs. However, the devices presented in [9] and [10] are stationary and have large overall dimensions.

The drum device presented in the study by A. Khramov [11] is designed for drying bulk materials. The study achieved an increase in drying performance and a decrease in specific energy consumption. However, the device is stationary and the drum is long.

In the study of A.P. Parpiev, R.D.Artikov, I.T.Tursunov, M.Akhmatov and I.D. Madumarov [12], a drum device for convective drying was developed. It is equipped with V-shaped blades and is designed for drying raw cotton.

In the research of O. Rakhmatov [13], an energy-saving device for drying was developed. It is intended for drying grapes.

In the study of B.P. Shaimardanov [14], the main parameters of the device based on the convective drying method were developed and substantiated. Research has been done for melon drying.

In [15], a stationary drum device for drying bulk materials is presented. In this device, the movement of the drum is provided on tires and support rollers using gears. In industry specimens, its length is 4-16 meters, diameter is 1-2.8 meters. The main disadvantages of this device are: non-uniformity of drying as a result of uneven displacement, large dimensions and the use of fuel oil and diesel fuels for drying.

Based on the analyzes carried out, it was determined that individual devices have a relatively low efficiency, complex design, stationarity and do not provide uniformity of drying due to the lack of uniform displacement during grain drying.

Based on the analyzes carried out, it was determined that individual devices have a relatively low efficiency, complex design, stationarity and do not provide uniformity of drying due to the lack of uniform mixing during grain drying.

Research results and their discussion

The aim of the research was to develop a new design of a drum drying device that ensures the quality of drying paddy with minimal energy consumption and substantiation of its parameters. And the goal of theoretical research was to determine the quantitative and qualitative indicators that change during paddy drying, as well as to substantiate the general requirements and parameters for the device being developed. Any drying device must meet technological and environmental requirements, be highly efficient and have low energy and physical costs for the drying process.

At present, sufficient theoretical data have been accumulated on heat and mass transfer in the process of convective drying of paddy. Therefore, it is possible to determine the theory of heat

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

treatment in the developed device. Convective drying of grain has been tested in practice, widely studied and widely used. This drying method uses heated air as the drying agent. With the convective drying method, the rate of heat transfer depends on the temperature of the heated air, the thickness of the grain mass, and the time of contact of the paddy with hot air. In particular, an increase in temperature when drying a paddy leads to a decrease in the amount of quality rice obtained during its processing.In particular, an increase in the temperature when drying a paddy leads to a decrease in the amount of quality rice obtained during its processing. Cycle drying should be carried out during drying in order to reduce the mass of the paddy and increase the contact time of the paddy with hot air. In view of the above and to ensure the quality of the heat treatment process, the technological scheme of the paddy dryer should include the following main parts.

The task of the proposed device is to ensure uniform drying of the paddy throughout the volume, that is, to improve the quality of drying and save energy. The assignment of such functions to the device is related to the following. According to the analysis of the literature, one of the main disadvantages of drying paddy in some existing dryers and in the natural (radiation) method is that the moisture level is not uniform throughout the volume of the dried product, i.e. the paddy dries unevenly. One of the main reasons for the uneven drying of the paddy is that it does not completely mix when drying.

When processing the dried paddy mound, it is important that the moisture level is uniform (uniform drying) throughout its volume. After the shala is dry, it is processed mechanically (by force). Its outer and inner shells are removed mechanically and rice is formed. The moisture uniformity of the dried rice is of particular importance in this process. Therefore, the main task of the device is to ensure uniform drying of the paddy throughout the volume.

The patented device is illustrated by the structural diagram shown in Figure 2. [16]. The proposed device uses a convective drying method for paddy. The principle of operation of the drying device for the paddy is as follows: A certain portion of the paddy is fed into the loading hopper 1, enters the screw conveyor 2, and then through the chute 3 is sent to the drying drum 4. As soon the drying drum 4 is filled in a certain portion of the paddy, the paddy is fed from the loading hopper 1 stops, and the adjustable slit 5 in the drying drum 4 opens. The shala is fed through a special chute 6 to the screw conveyor 2 for the next drying cycle, and the next drying cycle continues.

When the shala is dry, the finished product is lowered into the container 7 through the chute 17. Drying of the paddy is carried out using hot air in a drying drum. Hot air is generated by a heater 9 installed on a stationary section 8 and directed to the drying drum using a fan 10. The drying drum and screw conveyor are equipped with radial bearing bearings.

Complete mixing of the mass of the paddy by volume occurs on the screw conveyor 2 and the drying drum 4 and serves to ensure uniform drying of the paddy. The main part of the paddy drying process is carried out on a drying drum 4 with hot air. In addition, the drying process is additionally carried out by natural ventilation in the screw conveyor 2 and in the troughs 3, 6 and 17.

The proposed device differs from the above analogs in the following advantages:

- the drying drum in the device has 4 longitudinal internal ribs (see Fig. 1), which ensures effective mixing of the paddy mass;

- the screw conveyor 2 (see Fig. 1) transports the paddy to the drying drum, provides additional mixing of the rice and, in turn, increases the drying efficiency;
- its environmental friendliness is ensured by the fact that the device provides for the use of a heater 9 (see Figure 1) instead of fuel oil and related devices that pose a technical and fire hazard;
- the dryer can be made from local raw materials.

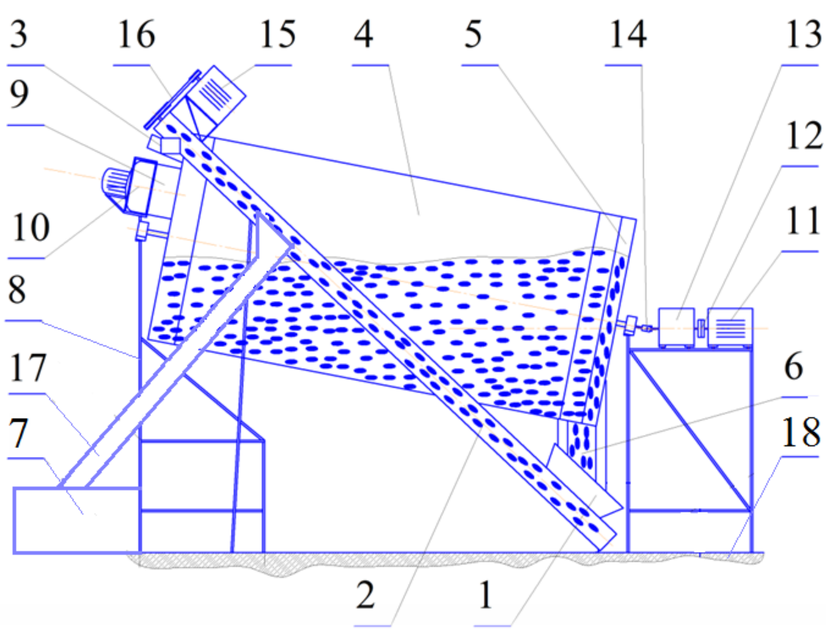

Figure 1.Constructive diagram of a drying device for a paddy

1 – loading hopper; 2 – screw conveyor; 3,6 и 17 – troughs;
4 – drying drum; 5 – adjustable slit; 7 – container; 8 – stationary section; 9 – heater; 10 – fan; 11, 15 – electric motors; 12, 14 – couplings; 13– reducer; 16 – Belting; 18 – base.

Analytical expressions for the kinematic parameters of the center of gravity of the paddy mass in the drying drum have been developed and determined.

Consider a rotating drum dryer of a device. The tumble dryer is a rotary system in terms of machine mechanics.

With the rotary movement of the drum, the geometric dimensions of the paddy mass change depending on the radius of the circle on which it rotates, that is, the radius of gyration. The radius of gyration is found as follows [17]

$$R_0 = \sqrt{(R_b^2 + R_v^2)/2}, \qquad (1)$$

where, R_b – dryer drum radius, м; R_v – inner radius of the paddy mass, m.

On the trajectory of the circular cross-section of the drum, the surface of the paddy mass changes at any moment, which can be determined using the following expression [17]

$$R_m(t) = K_1 R_0 + K_2 R_0 \sin(K_3 \omega t), \qquad (2)$$

where, $R_m(t)$ – radius of the variable center of gravity of the paddy mass, m; ω – drying drum angular velocity, rad/s; K_1, K_2, K_3 – coefficients taking into account the design dimensions of the drying drum [18].

We define the projection of the variable center of gravity of the paddy mass on the coordinate axis

$$y_c(t) = [K_1R_0 + K_2R_0\sin(K_3\omega t)]\cos(\omega t), \tag{3}$$

$$z_c(t) = [K_1R_0 + K_2R_0\sin(K_3\omega t)]\sin(\omega t), \tag{4}$$

where, $y_c(t)$, $z_c(t)$ – coordinates of the variable center of gravity of the paddy's mass.

We define the speed of the variable center of gravity of the paddy

$$v_{cy}(t) = K_2K_3R_0\omega\cos(K_3\omega t)\cos(\omega t) - \omega\sin(\omega t)[K_1R_0 + K_2R_0\sin(K_3\omega t)], \tag{5}$$

$$v_{cz}(t) = \omega\cos(\omega t)[K_1R_0 + K_2R_0\sin(K_3\omega t)] + K_2K_3R_0\omega\cos(K_3\omega t)\sin(\omega t), \tag{6}$$

$$v_c(t) = \sqrt{v_{cy}^2(t) + v_{cz}^2(t)}, \tag{7}$$

where, $v_{cy}(t)$, $v_{cz}(t)$ – the projections of the velocities of the variable center of gravity of the paddy mass on the coordinate axis; $v_c(t)$ – the absolute speed of the paddy's variable center of gravity.

We define the acceleration of the variable center of gravity of the paddy

$$\begin{aligned} a_{cy}(t) &= \omega^2\cos(\omega t)[K_1R_0 + K_2R_0\sin(K_3\omega t)] - \\ &2K_2K_3R_0\omega^2\cos(K_3\omega t)\sin(\omega t) - K_2K_3^2R_0\omega^2\sin(K_3\omega t)\cos(\omega t), \end{aligned} \tag{8}$$

$$\begin{aligned} a_{cz}(t) &= 2K_2K_3R_0\omega^2\cos(K_3\omega t)\cos(\omega t) - \\ &\omega^2\sin(\omega t)[K_1R_0 + K_2R_0\sin(K_3\omega t)] - K_2K_3^2R_0\omega^2\sin(K_3\omega t)\sin(\omega t), \end{aligned} \tag{9}$$

$$a_c(t) = \sqrt{a_{cy}^2(t) + a_{cz}^2(t)}, \tag{10}$$

where, $a_{cy}(t)$, $a_{cz}(t)$ – projections of the acceleration of the variable center of gravity of the paddy mass on the coordinate axis; $a_c(t)$ – absolute acceleration of the paddy's variable center of gravity.

In the MAPLE13 environment, programs were developed according to formulas 3, 4, 5, 6, 7, 8, 9 and 10 to determine the kinematic parameters - displacement, speed and acceleration of the variable center of gravity of the paddy mass in the drying drum. With the help of these programs, it is possible to represent the kinematic parameters of the variable center of gravity of the paddy mass in numerical and graphic form [19].

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

The graphs built on the basis of the programs are shown in Figures 2, 3, 4, 5, .6 and 7.

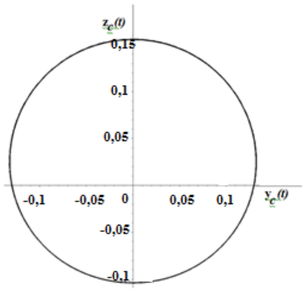

Figure 2. Trajectory of motion of the variable center of gravity of the paddy mass in the plane (R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

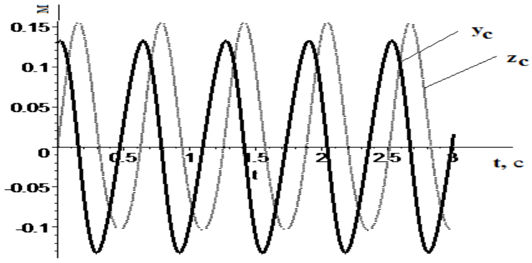

Figure 3. Changing the projection of the displacement of the variable center of gravity of the paddy's mass coordinate axes (R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

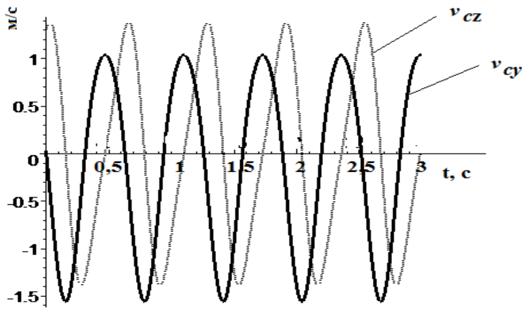

Figure 4. Changing the projection of the velocity vector of the variable center of gravity of the paddy's mass coordinate axes(R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

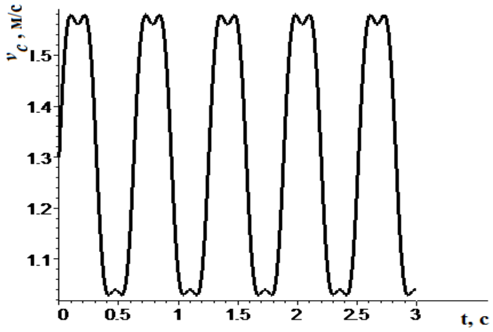

Figure 5. Change in the projection of the absolute speed of the variable center of gravity of the paddy's mass coordinate axes (R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

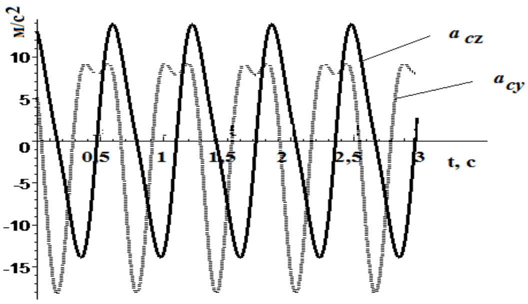

Figure 6. Changing the projection of the acceleration vector of the variable center of gravity of the paddy's mass coordinate axes(R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

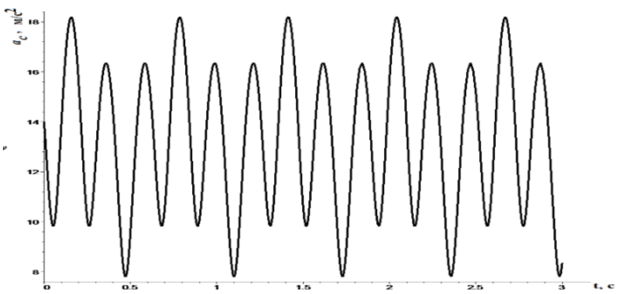

Figure 7. Changing the projection of the absolute acceleration of the variable center of gravity of the paddy's mass coordinate axes (R_b=0,44 м, ω=10 rad/s, K_1=1, K_2=0,2, K_3=1)

Based on certain kinematic parameters of the center of gravity of the paddy mass, the geometric dimensions of the drying drum of the device were found. The theoretical foundations of the formation of the working temperature of the drying agent in the drying drum and an experimental method for determining the specific heat of the mass of the paddy were developed [20, 21].

Discussion

The mobile device for drying paddy was produced at the Andijan pilot plant and tested at the farms “Teshaboi Ishonchi”, “Umida Saida Ishonchi” and “Khamidzhon Ishonchi” in the Izbaskan district of the Andijan region. Its technical characteristics is shown in Table 1.

Table 1. Technical characteristics of the developed mobile device for drying paddy

No.	Indicator name	Measurement unit of indicators	Value of indicators
1.	Drying efficiency (at moisture removal 6%)	kg / hour	150
2.	Adjustable slot width of the drying drum	sm	2,34
3.	Mass	kg	450±50
4.	Number of revolutions of the drying drum	min^{-1}	17
5.	Number of revolutions of the shaft of the screw conveyor	min^{-1}	100
6.	Air temperature in the drying drum	degree	up to 35°C
7.	Overall dimensions of the device: - length - width - height	mm	 3500 1500 2500

Drying paddy in a mobile device has been tested as environmentally friendly.

Conclusions

1. The devices for drying the paddy by the convection method were analyzed and it was found that high-quality drying is not achieved due to the low efficiency of some devices, the complexity of the design, large overall dimensions, and uneven mixing of the mass of the paddy.
2. Based on the analysis, it was decided that the purpose of the study is to develop a new design of a drum dryer that provides high-quality drying of a paddy with low energy consumption, and to justify its parameters.
3. Based on the analysis of scientific data, a technological, structural diagram of a mobile device for drying a paddy was determined and the principle of its operation was determined.
4. Determination of the kinematic parameters of the variable center of gravity of the paddy mass made it possible to find the geometric dimensions of the drying drum of the device.
5. A physical model and an experimental prototype of a mobile device for drying paddy have been developed.

Web of Discoveries: Journal of Analysis and Inventions
webofjournals.com/index.php/3

6. According to the technical characteristics, the developed mobile device for drying the paddy is recognized as energy- and material-efficient.

REFERENCES

1.SazzatH.S.Md.,MohdN.I., NorashikinA.A., MohdS.P.Energy and exergy analysis of industrial fluidized bed drying of paddy.Energy.–Malaysia, 2015. – pp. 131-138.
2.FirouziS., AlizadehM.Rez., HaghtalabD. Energy consumption and rice milling quality upon drying paddy witha newly-designed horizontal rotary dryer. Energy.– Iran, 2017. – pp.629-636.
3. DissanayakeaT.,BandaraaD.,RathnayakeaH.,ThilakarathneaB., WijerathnebD. Development of mobile dryer for freshly harvested paddy. Procedia Food Science.– Sri Lanka, 2016. – pp. 78–81.
4. SarkerM.S.H., IbrahimM. Nordin, AzizN. Ab., SallehP. Mohd.Energy and rice quality aspects during drying of freshly harvested paddy with industrial inclined bed dryer. Energy Conversion and Management.– Malaysia, 2014.– pp. 389 – 395.
5.BeigiM., Torki-HarcheganiM.,TohidiM.. Experimental and ANN modeling investigations of energy traits for rough rice drying. Energy. – Iran, 2017.– pp.2196 – 2205.
6.DanilovD.Yu. Development and justification of the parameters of an energy-saving cassette device for drying grain in farms. Diss. ... Candidate of Technical Sciences - Knyaginino, 2012. - 115 p.
7.SagyndikovaA.Zh. Improvement of the grain drying process by means of induction heaters. Diss. for the degree of Doctor of Philosophy (PhD). - Almaty, 2016. - 187 p.
8. RF patent 2506509 Device for drying grain.Kurdyumov V.I., Pavlushin A.A.B.I.– 2014.– No. 4.
9. RF patent 2509276 Grain dryer. Abdyushev M.M.B.I. - 2014. – № 7.
10. RF patent 2338984 Grain dryer. Tsuglenok N.V., Manasyan S.K., Demsky N.V. B.I. - 2008. - No. 32.
11. RF patent 2444686 Drum dryer.Khramov A.N. B.I. - 2012. - No. 7.
12. USSR patent 1814011 Dryer for raw cotton. Parpiev A.P., Artikov R.D., Tursunov I.T., Akhmatov M., Madumarov I.D. BI – 1993. – No.17
13.Rakhmatov O. Improvement of technology and technical means for drying and cleaning grapes. Diss. ... Doctor of Technical Sciences (DSc). - Gulistan, 2019 .-- 266 p.
14.ShaimardanovB.P. Justification of the main parameters of the working bodies of the machine for the preparation of melon fruits for drying. Diss. ...Cand. technical sciences. - Tashkent, 1989 .-- 193 p.
15.Convective dryers. –Mode access: http://www/prosesses-apparates.ru/articles /article_dryer_k2.htm (18.04.2019).
16. Patent of the Republic of Uzbekistan No. FAP 01403. Device for drying grain products.BekkulovB.R, AliyevR.,SobirovKh.A., NosirovI.Z., KayumovB.A, RakhmonkulovT.B. Official edition. - 2019. No. 7.
17. NematovE.Kh. Modeling the kinematics and dynamics of rotary drives for mineral crushers. Diss. ... Doctor of Philosophy (PhD) in Technical Science. -Toshkent, 2019. pp. 36-38.

18. Sokolov P.M. Fundamentals of calculation and design of machines and devices for food production: -M: Mechanical Engineering, 1983. pp.125-244.
19.Bekkulov B.R., Aliev R.U., Rakhmonkulov T.B. The movement of the paddy mound in the drum dryer. Certificate of the Intellectual Property Agency of the Republic of Uzbekistan. DGU 07757 02/19/2020.
20.Aliev R., Sobirov Kh.A., Bekkulov B.R. Determination of the optimal temperature in the drying drum of a mobile grain drying device // Tashkent State Technical University, Bulletin of Tashkent State Technical University. - Tashkent, 2018. - No. 4. - pp. 107 - 112.
21. Bekkulov B.R., AliyevR.U.,KhalilovM.T., Mamirov Y.T., JalolovaZ.X.Experimental research for paddy and rice// International Journal of Advanced Research in Science, Engineering and Technology. – India, 2018. – Vol. 5, Issue 7. – pp. 6327 – 6331.