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WORKING OUT OF THE POWER EFFECTIVE DESIGN MOBILE GRAIN-DRYER INSTALLATIONS

РАЗРАБОТКА ЭНЕРГОЭФФЕКТИВНОЙ КОНСТРУКЦИИ ПЕРЕДВИЖНОЙ ЗЕРНОСУШИЛЬНОЙ УСТАНОВКИ

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Abstract. The new design of the mobile device for grain drying is described. Advantages of the given design of the device in comparison to the analogues - grain draying are shown. The results of the field tests of the developed device are resulted. Problems of using renewable energy sources for the maintenance by electric energy of the new device at operation in the districts kept away from an electric network are offered.

Аннотация. Описана новая конструкция передвижного устройства для сушки зерна. Показаны преимущества данной конструкции в сопоставлении с аналогами – сушильными устройствами. Приведены результаты полевых испытаний разработанного устройства. Предложены использование альтернативных источников энергии для обеспечения электрической энергией нового устройства при эксплуатации в отдаленных от электрической сети местностях.

Keywords: the device for grain drying; radiating and convective ways of drying; a heater; heat conductivity; temperature conductivity; thermal-humidity conductivity; a thermal capacity.

Ключевые слова: устройство для сушки зерна; радиационный и конвективный способы сушки; калорифер; теплопроводность; температуропроводность; термовлагопроводность; теплоемкость.

Drying of grain crops is an important stage of assemblage of the crop, is promoting quality end-product. The drying process gets the highest importance especially in a damp season and cloudy weather days. Traditionally the widespread way of radiating drying is applied to this purpose. But for this purpose it is required the big asphalted areas, it is a lot of time till several sunny days and process rather labour-consuming. Besides it is difficult to provide uniformity of degree of drying of grain (1).

Dried till degree of humidity no more than 6 % grain is exposed to further machining for clearing of an external bark. For example, quality of a rice – final after product machining essentially depends on uniformity of humidity dried up rice (not cleared rice).

In practice for this purpose various designs effective drying installations re used (2-4). Such dryers are stationary, dimensional and use mach fuel or electric energy.

For the last 20 years in our country the great attention on repeated cultivation of grain and leguminous cultures as secondary crops, after assemblage primary - autumn wheat is given. The season of gathering of secondary grain often coincides with cloudy autumn days, so if for this purpose to use stationary dryers with productivity not less than 5 ton/hour, material expenses strongly increase till 325 thousand sum/hour; plus an additional cost of transportation. Therefore it is represented the most actual problem - working out of power effective and mobile designs of the drying devices.

The author of the given work offers a new design of the dryer, allowing to realise a convective way of drying of a grain [1]. Offered drying the device thanks to the constructional feature, dynamics of working bodies and use of new technical decisions provides one-dimensionality of drying on the volume of the loaded portion of grain.

By design calculations the initial pre-production model of the device for drying of the products of grain crops is made and primary test is made primary experimental results (Figure 1), hence, are received.

The device test was spent in a stationary mode using an electric current frequency of 50 Hz, by voltage 380 V. It was running in a current of 3 hours, then, for experiment the portion of a dried up product of grain crops in volume of 150 kg of a rice , grades of "Alanga" is allocated. Humidity of initial grain made W_1=10 % before drying and W_2=6 % after drying in a current of hour. Thus, primary productivity of the device for a product of grain crops has made 150 kg/hour. The basic indicators of primary experiment are resulted in Table 1.

a) b)

Figure 1. An initial pre-production model of the device for drying of the products of grain crops:
a) general view; b) kind of the nutritious bunker and a trench

Table 1.

Consumable power devices, KW	*Air temperature, 0C*	*Atmospheric pressure, mm.Hg*	*Relative humidity of air, %*	*Temperature in a drying drum, 0C*	*Temperature of weight of rice, 0C*	*All dried up rice, kg*	*All the dried up rice, kg*	*Duration of drying, minute*	*Productivity of drying of the device, kg/hour*
4,5	32	714	35	45	30	150	144	60	150

The received experimental data in comparison with drying installations of type CM-1 are resulted in Table 2 (5). Advantages of the offered device to grain drying are obvious on separate indicators: power consumption and fuel, overall dimensions

Table 2.

Device kind	*The expense electro energy, kW/hour*	*The expense of diesel fuel, l/hour*	*The productivity of drying, kg/hour*	*Expenses for grain drying, sum/kg*	*Overall dimensions, mm3*
CM-1	32	80	5000	65	8600x3120x7600
The offered devise for grain drying	4,5	-	150	60	3000x1500x2000

The offered device has been noted allows to realise more effective way convective grain drying. Works for the purpose of comparison of productivity of two ways of drying of grain are performed: radiating and conventional. Experiments on drying of a separate portion of rice grades of Alanga in volume quantity of 150 kg with initial humidity W_1=10 of % to final humidity W_2=6 of % in the radiating (natural) way in a current of 3 hours on the asphalted platform and convective in the way by means of the developed new device are put. From dried up rice are received rice and pug (broken rice) by means of traditional machining by means of the standard device. Measurement of weight of end-products and an industrial waste is made. The received experimental results are resulted in Table 3.

Comparison of experimental data of drying of grain and reception from them end-products testify to some increase quantitative and quality indicators of useful foodstuff.

Table 3.

Way of drying	*Weight of rice (not cleared rice), kg*	*The cleared rice, kg*	*Pug (broken rice), kg*	*Rice bark, kg*	*Forage, kg*	*Invisible rubbish, kg*
Radiating way	144	98	7	14	20	5
convective way (by means of the offered device)	144	102	3	14	20	5

Research of physical properties of grain as porosity, flowability, a slope corner, a thermal capacity, heat conductivity, diffusivity and thermo hydraulic conductivity in process of drying by means of the developed device is conducted (6). At grain passage through screw the distance of bough from grain (Figure 2) is observed. Hence, has decreased porosity.

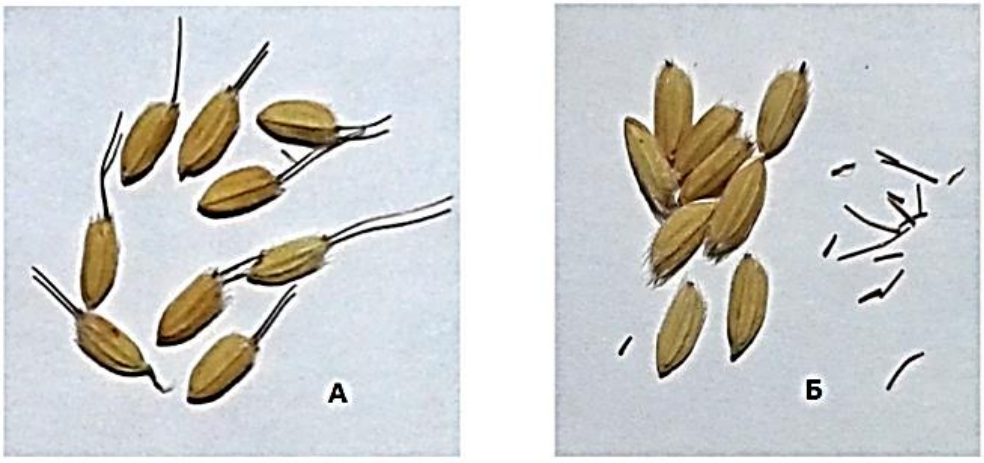

Figure 2. Photos of samples of grains rice (not cleared rice) to (А) and after (Б) drying by means of the developed device

That has increased flowability of grain. The flowability increase has led to reduction of a corner of a slope of rice and it has special value in the course of grain processing. Besides, porosity decrease has led to reduction of air spaces between grains and grain weight as a whole that is the positive factor. It is known that air is a bad conductor of heat, temperatures, a moisture and has rather great value of a thermal capacity. Decrease in porosity of grain has led to increase in their heat conductivity, diffusivity, thermo hydraulic conductivity and as a result, to reduction of value of a thermal capacity. It is known that demanded quantity of warmth for drying realisation in direct ratio to value of a thermal capacity. Thus, the decrease quantity of the warmth claimed for drying of grain that was the deliberate purpose of the given work out is reached.

Necessity of local drying of grain on the various districts which have been kept away from lines of the electric system represents a working out urgency to execute in the form of a mobile design. For supply by electric energy mobile drying devices are offered following variants of use of alternative energy sources:

- The silicon solar battery with the corresponding: the controller, the accumulator and inverter;
- An internal combustion engine (ICE) of the an automobile.

On Figure 3 it is presented the simplified schematic kind mobile drying devices, on a roof 2 (with the area of 16 m^2) which installation of the solar battery is provided.

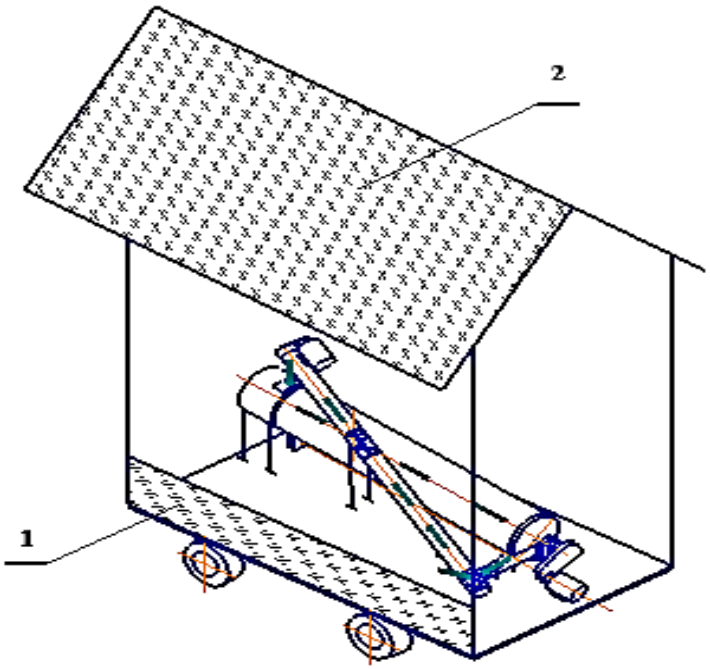

Figure 3. A kind mobile drying devices

It is known that, using 1 m^2 solar panels it is possible to receive about 200 W of electric energy (7). Accumulation photoelectrical energy allows to create power station with target capacity to 3,6 KW that is enough for engines of the fan , a drying drum , screw , the general consumed capacities in the sum makes 1,4 KW. For maintenance with warm air in a heater use of the two-planimetric solar collector 1 developed of solar energy (8), having parametres are provided: factor of absorption of sun rays 0,95; a useful area 2 m^2.

In case of use as alternative energy source ICE, for example, ICE fuel consumption - 2 litres of gasoline or 2,5 litres liquefied gas for which account by means of the generator electric energy (Figure 4) is developed more than 30 kW*hour) is available capacity of the car of mark MATIZ of 49 h.p.

Figure 4. The developed source of electric energy on the basis of ICE the car of mark MATIZ.

The generator has overall dimensions 700x800x900 that allows to establish structurally it under a drying drum of the device, specified Figure 4. The created electric current capacity more than 30 kW*hour, frequency of 50 Hz, voltage 380 V is more than enough for provision of energy of the process of drying of the grain. Power consumption for the given device of drying of grain makes 4,5 kW. The received excessive capacity of electric energy can be used for illumination, cooking and other needs in field of conditions.

Table 4.

Kind of used energy	*The gasoline expense, litre/hour*	*The productivity of drying, kg/hour*	*Material th expense, sum/kg*	*Possibility of increase of productivity of drying*
(Alternative) Solar batteries	-	150	-	Is available
(Alternative) ICE the car	2	150	37	Is available
Electric energy	-	150	60	Is not available

Given Tables 4 testify to real advantages of operation of the developed mobile device for drying of the grain, provided use of alternative energy sources.

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