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STUDY OF THE INFLUENCE OF THE DRYING AGENT SPEED ON THE OPERATION
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ИЗУЧЕНИЕ ВЛИЯНИЯ СКОРОСТИ СУШИЛЬНОГО АГЕНТА НА РАБОТУ
КОМБИНИРОВАННОЙ ЭНЕРГОСБЕРЕГАЮЩЕЙ БАРАБАННОЙ СУШИЛКИ*Сафаров Элёрбек Хасанович*

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ABSTRACT

This article presents a new combined drum energy-saving dryer for drying sunflower seeds, which additionally uses solar thermal energy. The effect of changing the speed of the drying agent on the drying intensity and energy efficiency of the dryer was also studied, and the experimental results were fully described and analyzed. Conclusions are made based on the values obtained in the experiment.

АННОТАЦИЯ

В данной статье представлена новая комбинированная барабанная энергосберегающая сушилка для сушки семян подсолнечника, использующая дополнительно солнечную тепловую энергию. Также было изучено влияние изменения скорости сушильного агента на интенсивность сушки и энергоэффективность сушилки, а результаты экспериментов были полностью описаны и проанализированы. Выводы сделаны на основании значений, полученных в эксперименте.

Keywords: sunflower seeds, drum dryer, solar energy, energy saving, solar collector, combined dryers.

Ключевые слова: семена подсолнечника, барабанная сушилка, солнечная энергия, энергосбережение, солнечный коллектор, комбинированные сушилки.

Introduction. Sunflower (*Helianthus annuus* L.) is currently one of the most important oil crops in the world. Over the past five years, sunflower has been grown in 72 countries on an average of 25-26 million hectares and harvested an average of 40.5-42.0 million tons. In particular, in Uzbekistan in recent years, the acreage of sunflower has increased by 17.5 thousand hectares, and the average yield is 12-15 kg/ha [1].

Freshly harvested sunflower seeds have a moisture content of 15% to 50%, and long-term storage requires drying to a moisture content of 8-10%. In addition, by drying, the nutritional and various biochemical properties of grains and oilseeds are preserved for a long time [2, 3].

There are many types of dryers, each of which has its advantages and disadvantages in terms of application and principle of operation. Much attention is paid to the development of combined dryers by eliminating the existing disadvantages of dryers with the advantages of other types of dryers [4]. There is also an increasing demand for creating dryers as energy efficient. To meet this requirement, it is necessary to additionally use renewable energy sources and develop the design of dryers in such a way as to ensure the storage of thermal energy.

Based on this requirement, a project was developed for a combined energy-saving drum dryer [5] and a drying device was manufactured on its basis.

This dryer can also be used in mobile mode. Such characteristics of the dryer increase its usefulness.

Materials and methods. With the relative simplicity and suitability of its construction, drum dryers differ from other dryers, therefore they are widely used in various industrial sectors [6]. Drying in a drum dryer can be done by convective and contact methods [7, 8, 9]. In a drum dryer, changing the speed of the drying agent has a significant effect on the drying process, and the residence time of the wet material in the dryer is reduced [10, 11].

Many works have been done on drying using solar thermal energy [12, 13]. In solar dryers, solar energy can

be stored in order to use thermal energy even when there is no sun [14].

To increase the productivity and drying speed of the drum dryer, changes were made to the design of the dryer, additional solar thermal energy was used, a new pilot plant of a combined energy-efficient drum dryer was developed (Fig. 1). Experimental work was carried out to study the drying process.

The purpose of the experiment is to study the effect of the drying rate of the drying agent on the drying intensity and energy efficiency of the dryer. Figure 1 shows the general scheme of an experimental dryer made according to the project.

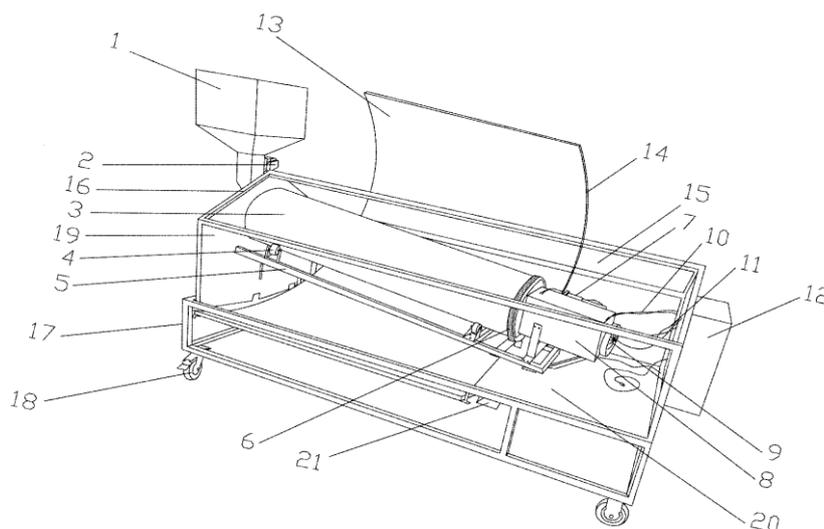


Figure 1. Scheme of a combined energy-saving experimental drum dryer: 1-loading hopper, 2-stepper motor with grain flow adjustment, 3-drying drum, 4-rotating rollers, 5-support on which rotating rollers are fixed, 6-gear wheel mounted on a drum, 7 - drum rotating motor, 8- electrocalorifer, 9- ventilator, 10- electrocalorifer current supply conductor, 11-sensor cables transmitting temperature information, 12-control cabinet, 13- reflector in the form of a parabolic tube, 14- fixed metal profile of the reflector, 15-solar collector, 16-metal frame of the solar collector, 17-lower support part of the dryer, 18-wheels for moving the drying device, 19-metal panel for fencing the solar collector in front, 20-metal panel for fencing the solar collector from below, 21-unloading hopper

The dryer consists of a loading hopper 1, an motor that consumes loaded seeds 2, a drying drum 3, on the drum of which rollers 4 rotate, a support on which rollers 5 are fixed, a motor that rotates the drum with a gear wheel 6, an electric furnace (electrocalorifer), generating heated air 8, fan 9 directing the heated air to the dryer drum 3. The conductor 10 supplying the electrocalorifier 8 with electric current and the cables of the sensors 11 measuring the temperature at the corresponding points are connected to the control cabinet 12. In addition, there is a reflector 13 in the form of a parabolic tube, fixed on a metal profile 14 and heats the air in the solar collector 15 and the drying drum 3. The metal frame 16 of the solar collector 15 is hermetically sealed from above and from the sides with transparent plastic glass, in which air heated by the thermal energy of the sun is collected and stored. The solar collector 15 has lower support 17, with the help of mobile wheels 18 fixed on this support, the device can be easily moved from place to another, and the solar collector is blocked from the front and bottom by means of metal panels 19, 20. Dried sunflower seeds fall from the unloading hopper 21.

At four points of the experimental dryer, i.e. at the dryer inlet, solar collector, electric furnace and dryer outlet, sensors are installed that measure the temperature and transmit it to the control cabinet. The temperature controller type REX-C400FK02-M*AN-RELAY in the control cabinet regulates the temperature of the heated air leaving the electric furnace to the set value depending on the temperature of the heated air in the solar collector. The adjustment process is carried out by switching the JGX-1 D48100 relay in the control cabinet. As a result of switching the relay, the electric oven is also turned off.

The ratio of the relay off time to the on time varies depending on the temperature of the air entering the electric furnace heated in the solar collector, that is, the higher the temperature, the longer the relay off time. This provides significant savings in electricity supplied to the electric furnace. Since the solar collector includes a drying drum and an electric furnace, it allows you to save electricity even in indoor conditions.

To use the experimental dryer in a mobile position, movable wheels are installed (Fig. 2). The purpose of this is to dry the sunflower seeds grown on the farm.



Figure 2. Combined energy-saving experimental drum dryer: a – indoor conditions; b - in the field

Results and its discussion. The experiment was carried out indoorconditions and in the field in mid-summer and autumn. The experiment was carried out at drying temperatures of 80°C, 90°C, 100°C. The effect of changing the speed of the drying agent on the power consumption of the electric furnace and the change in the mass of dried sunflower seeds was studied. The speed

range of the drying agent is 0.5 ÷ 1.5 m/s, the total power consumption of the electric furnace is 4500 W.

The effect of changing the speed of the drying agent on the power consumption in the electric furnace at drying temperatures of 80°C, 90°C, and 100°C was studied indoorand field conditions in the summer and autumn months (Fig. 3).

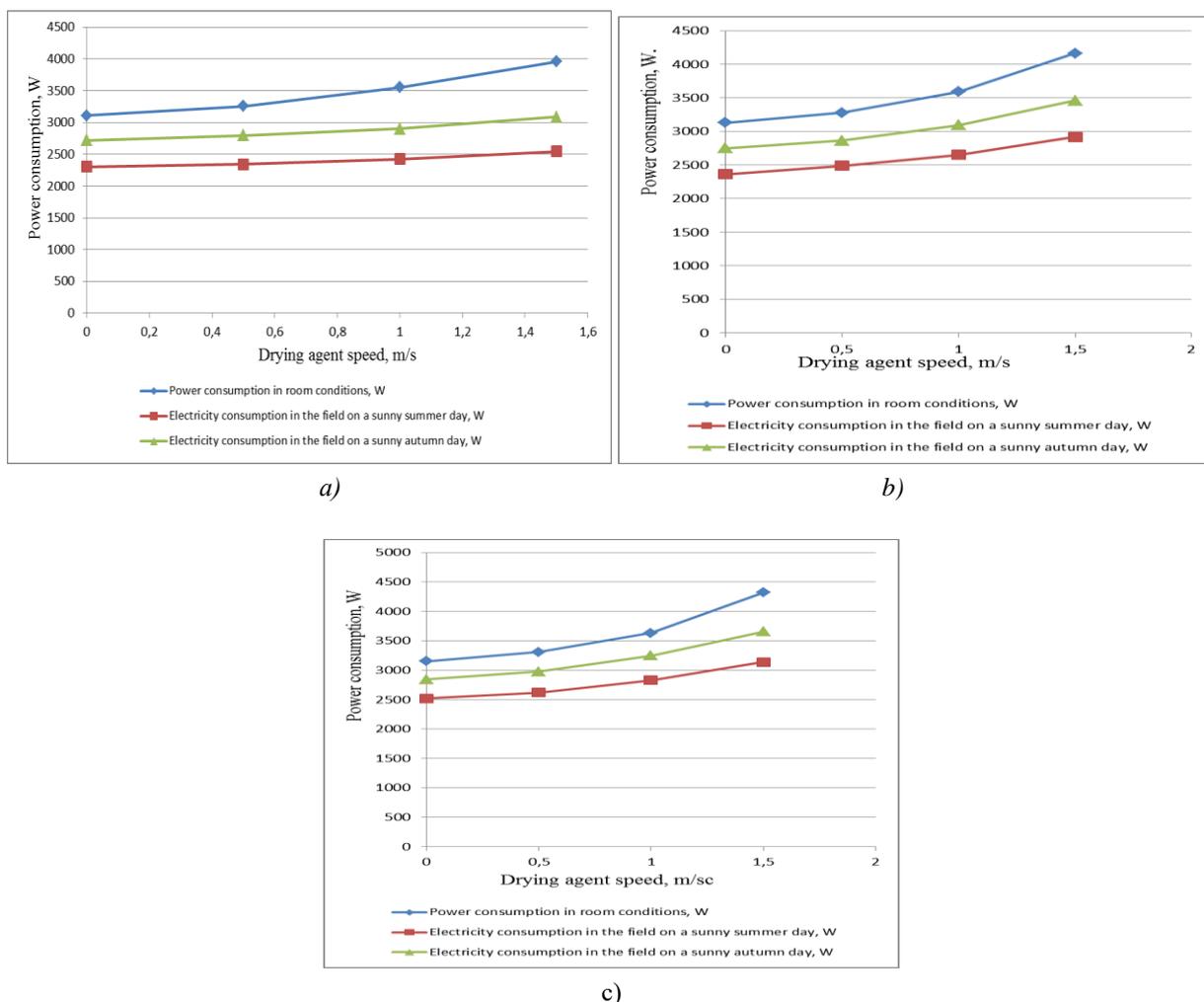


Figure 3. Influence of drying agent speed on power consumption: a – at the drying temperature of 80°C, b – at the drying temperature of 90°C, c – at the drying temperature of 100°C

An experimental study shows that an increase in the speed of the drying agent leads to an increase in electricity consumption. This can be explained by the fact that more time is spent on heating the atmospheric air in the electric furnace to maintain the drying temperature at a constant value. With an increase in the drying temperature, the consumption of electricity also increases. An increase in the speed of the drying agent to 1.5 m / s causes an increase the power consumption

of the electric furnace by an average of 22.6% in indoor conditions, by 10.4% in summer in the field and by 14% in autumn in the field at drying temperatures 80°C, 90°C, 100°C.

The changes in the mass of dried sunflower seeds at a drying temperature of 80°C, 90°C, 100°C in the field during the summer and autumn months with a change in the speed of the drying agent up to 1.5 m/s were studied (Fig. 4, 5).

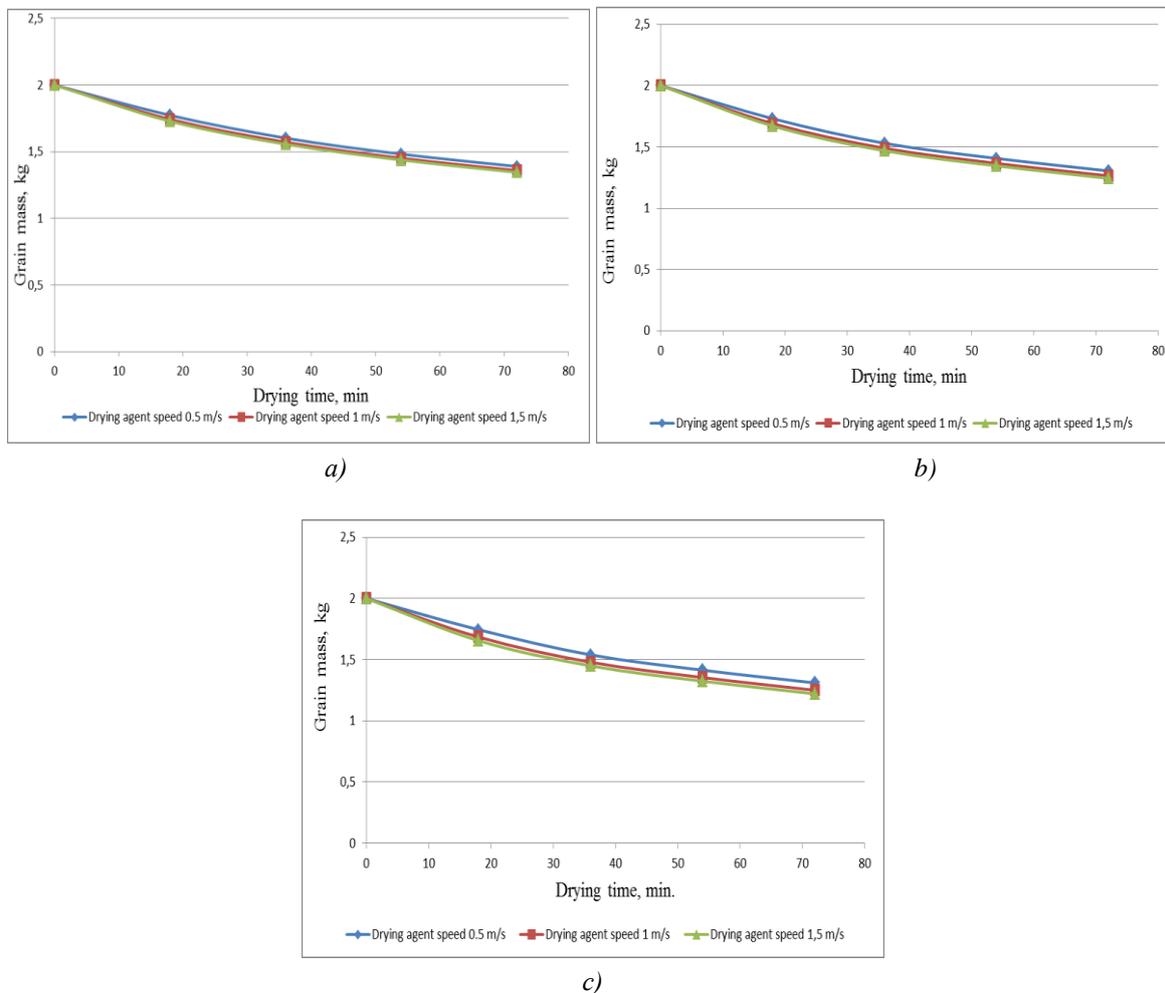
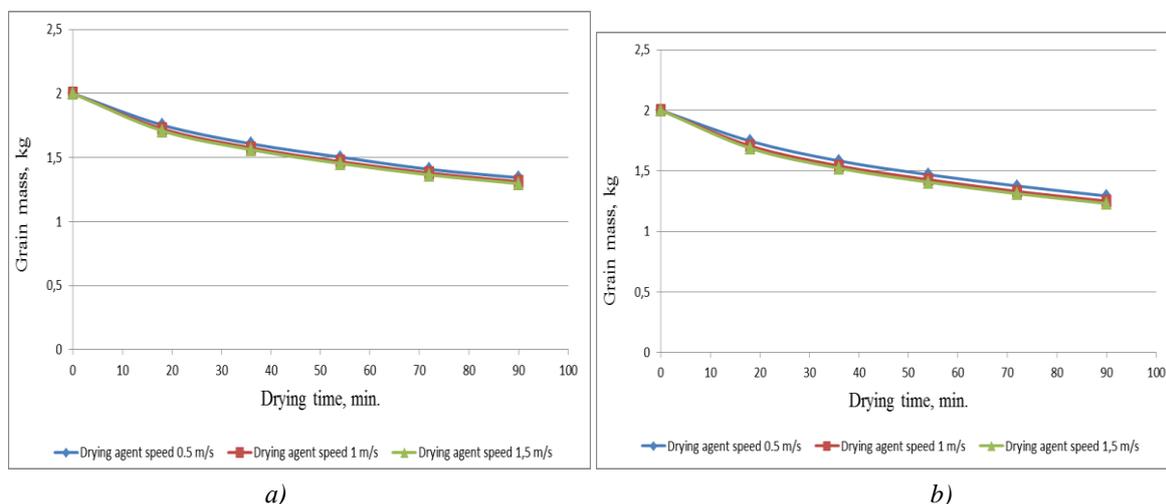
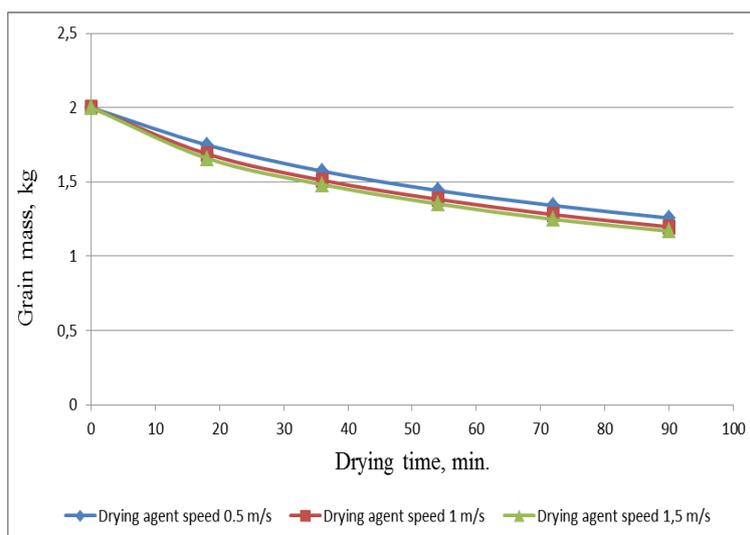


Figure 4. Influence of the speed of the drying agent on the removal of grain mass in the field during the summer period: a - at the drying temperature of 80°C, b - at the drying temperature of 90°C, c - at the drying temperature of 100°C





c)

Figure 5. The effect of changing the speed of the drying agent in the field in autumn on the removal of grain mass: a - drying temperature 80 °C, b - drying temperature 90 °C, c - drying temperature 100 °C

The curves depicted in Figures 4 and 5 represent the increase in sunflower seed mass removal with increasing drying temperature and drying agent consumption. Mass removal reaches its maximum value at a drying temperature of 100°C and a drying agent speed of 1.5 m/s.

The mass removal values at the drying temperature of 80°C in the field in summer at the drying agent speed of 1 m/s correspond to the mass removal values in autumn at the drying agent speed of 0.5 m/s at the drying temperature of 90°C.

Also, the values of mass removal at the summer field drying temperature of 80°C, the drying agent speed of 1.5 m/s can be achieved at the autumn field drying temperature of 90°C, the drying agent speed of 1 m/s. At the same time, all values of mass removal at the summer field conditions at the drying temperature of 90°C correspond to all values of mass removal at the autumn field conditions at the drying temperature of 100°C, depending on the change in the speed of the drying agent.

Let us summarize all the results of the experiment. An increase in the values of the drying temperature and the speed of the drying agent causes an increase in the values of the removal of the mass of dried sunflower seeds and the power consumption of the electric furnace.

When drying indoor conditions, field conditions in the summer and autumn months, with an increase in the speed of the drying agent to 1.5 m/s, the electricity

consumption in the electric furnace increased by 1018 W, 470 W and 631 W, respectively. For drying sunflower seeds to a moisture of 8-10% for a long time, it is recommended to set the drying temperature at 90°C in summer, 100°C in autumn, and the speed of the drying agent at 1 m/s.

Conclusion. The combined energy-saving drum dryer was built and tested, which performs drying at the expense of additional natural thermal energy of the sun. Studies have been carried out to study the effect of changing the speed of the drying agent on the intensity of drying sunflower seeds and the energy saving of the dryer in the summer and autumn months of the year in field and room conditions. Based on the results of the experiment, we can draw the following conclusions:

- Increasing the speed of the drying agent up to 1.5 m/s at drying temperatures of 80°C, 90°C, 100°C increases the energy consumption of the electric furnace by an average of 22.6% indoor conditions, by 10.4% in summer field conditions conditions and by 14% in autumn field conditions and is 1018 W, 470 W and 631 W, respectively.

- To dry sunflower seeds at the required moisture for long-term storage, it is recommended to dry them at the drying temperature of 90°C in summer and at a drying temperature of 100°C in autumn, adjusting the speed of the drying agent to 1m/s.

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