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ENERGY-SAVING EQUIPMENT AND TECHNOLOGY FOR AGRICULTURAL AND FRUIT-VEGETABLE DRYING

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Abstract. The article describes the recommended drying methods and the selection of the most efficient modes for drying units. An additional method of thermal radiation for a vacuum chamber using phase shifting of the heat carrier is presented. The technology of the energy storage process, the structure of the device and the diagram of the process of using the energy stored in the device are analyzed. Based on the analytical review of scientific and applied research, investigation on the drying of various agricultural products, fruits and vegetables, other products in world practice, the results of theoretical research, proposals for the development of specific designs of mechanisms are used in technological machines.

Keywords: drying, agricultural products, fruits and vegetables, energy storage, paraffin, drying chamber, heat storage, heat energy, heat carrier, evaporation.

Introduction.

One of the urgent tasks of agriculture in the world level is the production of dried products from fruits and vegetables, including agricultural products, fruits and vegetables. The problems of increasing the efficiency of drying machines, apparatuses, units, devices for energy and resource saving as a result of mechanization of production processes in agricultural engineering, as well as the development of scientific and methodological foundations for assessing their economic efficiency and resource saving, are considered. At the same time, one of the main tasks is to reduce the energy and resource intensity of the economy, the widespread introduction of energy-saving technologies in production, increasing labor productivity, etc. One of the most important tasks is the implementation of these rules, including the development and utilizing of modern efficient technologies and devices, as well as the reduction of specific indicators of the use of fuel and energy resources.

Literature review

Drying is a process in which free or bound volatile liquid is removed from a solid by evaporation. Currently, there are many different drying technologies: natural, ventilation, convective, freeze-drying, infrared and microwave drying, etc. This process is an actual problem of many scientific studies [1, 2, 3, 4, 5].

The drying process is an important and energy intensive process in all industries. There are more than two hundred types of drying in the industry, in which the dependence of parameters

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on the drying material and drying conditions can be observed. This means that many experiments have been carried out in this regard.

Foreign and domestic scientists conducted a number of scientific studies aimed at solving the following problems:

- Decreased energy efficiency and resource intensity in drying agricultural products, fruits and vegetables, increasing the productivity of dryers;
- Obtaining separation means to ensure energy saving when drying fruits and vegetables;
- Creation of technologies that ensure the preservation of biologically active substances during the drying of fruits, vegetables and agricultural products;
- Development of a drying regime that ensures the selection of drying parameters for agricultural products, fruits and vegetables;
- Designing of drying devices that provide artificial propagation of seeds for drying;
- Project of drying equipment for drying agricultural products, fruits and vegetables in the field;
- Creation of new efficient technologies and technical means for simultaneous drying and processing of agricultural products, fruits and vegetables and other similar scientific researches [8, 9, 10, 11, 12].

In general, based on an analytical review of scientific and practical research, it should be noted that in the global practice, scientific research is being carried out on the drying of various agricultural products, fruits and vegetables, bulk materials, and in most cases, the results of theoretical studies are correct. The development of precise designs of mechanisms used in technological machines remains a requirement of the time. Based on the foregoing and aimed at improving technologies, it is frequenly necessary to strengthen investigation and scientific and technical solutions on the development of projects of energy-saving devices and portable devices for drying agricultural products, fruits and vegetables based on new innovative concepts. [4, 5,6,7,11,12].

The currently used methods for drying agricultural products and various fruits and vegetables in the processing industry require the use of new processing technologies that improve the quality of the final product, reduce processing time, and improve the quality of dehydrated raw materials.

The use of new technologies in drying processes, equipped with a thermal field for drying products, a vacuum drying device with a liquid-phase heat carrier, and a heat accumulator, is undoubtedly effective in technological processes for the production of products. [13,14,15].

Another important requirement for drying plants is the preservation of biologically active substances at a temperature of t - 55 °C. It is known that when drying with the use of firewood, gas and sunlight, the coolant overheats, therefore, conditions arise for the deterioration of bioactive substances. The appearance of a paraffin heat exchanger makes it possible to remove excess thermal energy due to the transition from a solid to a liquid state. 1 ton of paraffin can store 48 kWh of phase change energy; as for the price of electricity, it is 1000 sums, which makes it possible to obtain 40 liters of distilled water from products [4,5,6,7,8,9,11,12].

Discussion and results.

The heat accumulator is very important in the agriculture of Central Asia, in the industry, heating greenhouses and heating system of houses. If high temperature radiation is permitted, kerosene may also be used. Its melting point is higher than paraffin's, 35-88°C, depending on the composition: grades "75" or "85". For heat storage with paraffin, the greatest economic effect is obtained when using unrefined varieties of kerosene.

The amount of heat supplied to the device is stored in a heat accumulator filled with paraffin and hermetically sealed. If it is disconnected from the power source and continues the heat exchange cycle, it releases the necessary energy (Fig. 1).

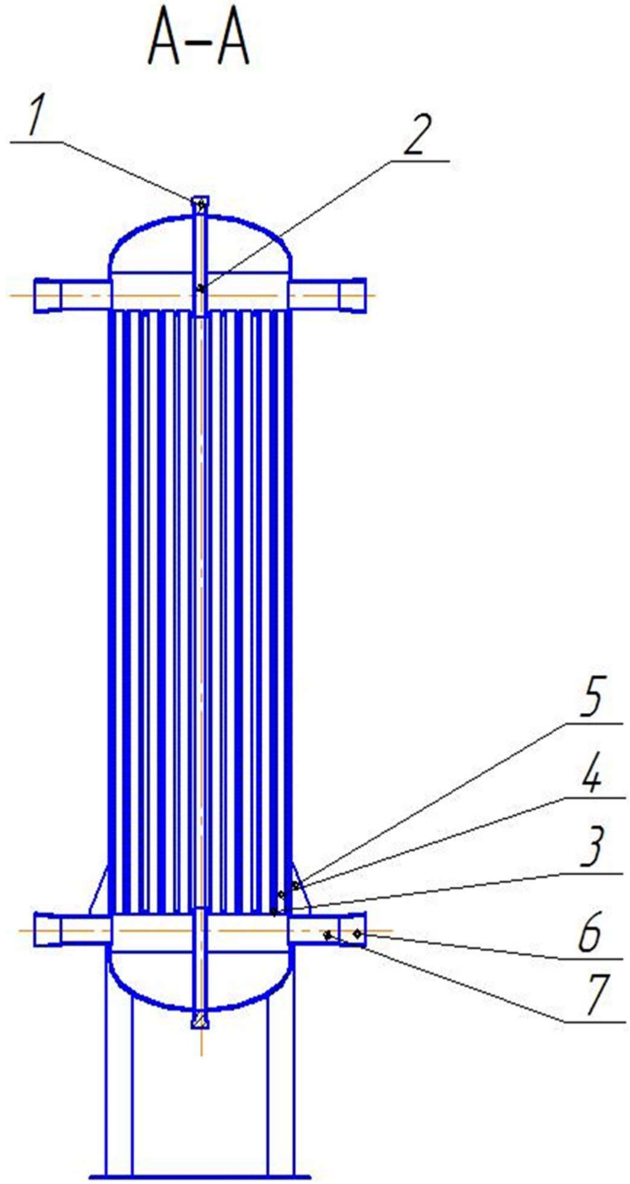

Figure 1. Heat accumulator: 1-inlet valve; 2-tube with valve; 3-Paraffin pipes; 4-paraffin; 5-holder; 6-faucet; 7-tube.

Once heat has been applied to the thermopile dryer and the wax has been heated, the external energy source can be switched off. It does not allow irradiating the energy carrier with intense heat rays when the temperature of the energy carrier does not exceed 95 °C, accumulating a lower temperature of the energy carrier. The low electrical conductivity of paraffin reduces the regeneration process. Oil heaters of the system have an oil volume of 180 liters, it uses transformer oil, boiling point 350 °C.

Paraffin additives help to smoothly raise the boiling point to 450-550 °C.

The above will help raise the optimum radiation temperature to the optimum level. Thermal radiation of this frequency is well absorbed by hard varieties of fruits and vegetables. When the top layer of fruits and vegetables dries out, moisture remains inside, so heating must be stopped.

Electrical disconnection of voltage causes a rapid decrease in radiation. Therefore, the presence of oil in the system balances the thermal inertia. For example, it is proposed to use the stored energy to reduce the mass of paraffin (600) grams. In doing so, we have two useful processes;

1. With mild temperature conditions, we will have an additional 40 liters of water evaporation.
2. It can save 24KWh of energy in one cycle.

As is known, any geleo device (operating in liquid heat conduction) is periodic (15,16,17). It should also be noted that the collection of geleo as a whole lead to an increase in atmospheric air, since the temperature in the open air during the day in the steppe zones can vary by 30 °C.

Solar energy not only heats the liquid conductor, but also heats the surrounding air on a large scale, as a result of which we observe periodic temperature drops up to 90 °C.

The most important in this method is the storage of energy, which occurs as a result of the phase transition of the coolant from a liquid to a solid state or vice versa. The use of the energy of the gas-liquid phase transition requires large capacities, which limits the economic effect of their practical application. Therefore, the use of melting energy can be very efficient, since during the phase transition, 1 kg of paraffin energy is enough to heat 7 kg of water to 500°C.

In practice, the cost of such storage is advantageous when combustible materials are used to heat the carrier. In particular, firewood, fuel oil and other organic fuels are available in steppe and mountain conditions. Their thermal conductivity is impulsive, the coolant often overheats. If this excess heat is accumulated, the efficiency of using this type of fuel increases.

Here the oil is heated up to 250°C. If transformer oil is chosen as the coolant, then this value is close to practical values in technological processes. Efficiency is directly related to the surface temperature of the heating system, which also increases with heat due to the temperature of the oil.

As the difference between these values increases, the heat exchange efficiency of the heating system heater increases. From the exact scheme of the proposed mode, it can be seen that stage 1 is an energy accumulation process in the absence of carrier overheating, i.e. $t < 250°C$. The system helps to reduce the heating temperature of the heat transfer fluid. If we assume that there is a mass of paraffin in the dryer, then XM energy is required to heat it, where X is the specific melting coefficient of 150 kJ/kg. This energy is stored in normal operation, when the heating system is operating efficiently, i.e. not heating up.

During this cycle, the efficiency of the heating system is increased by 600°C at an average power of additional energy increase, as shown above.

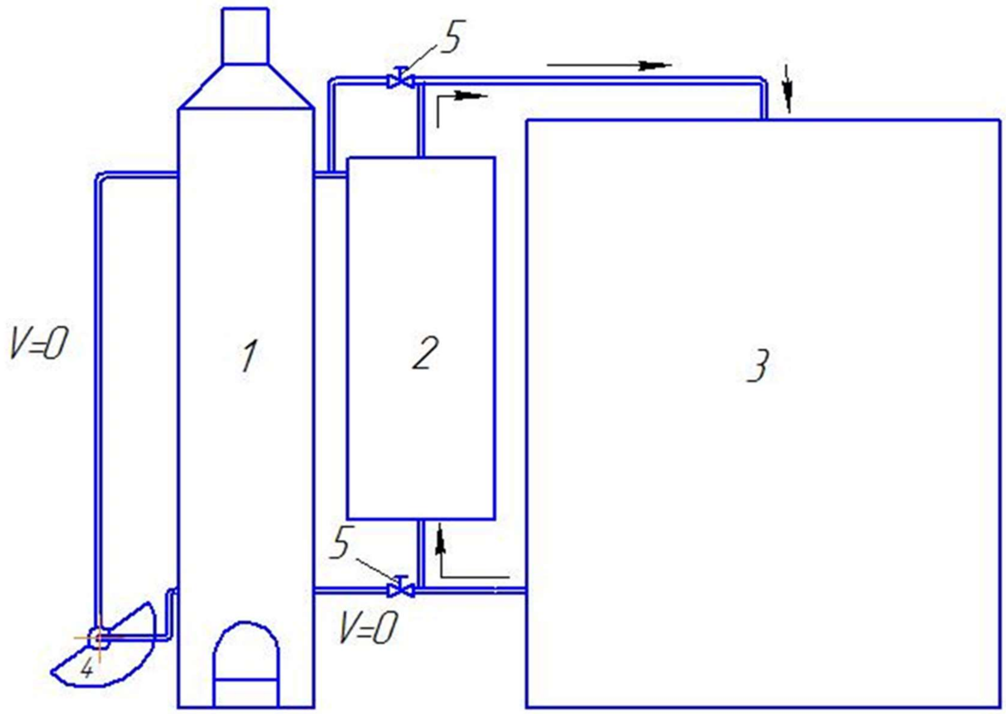

Figure 2. The process of using stored energy:

1 – water tank; 2 - thermal energy accumulator; 3 - vacuum chamber; 4 - parabolic solar heater; 5 – ball valve for closing and opening heat carrier.

Here the process occurs when the battery is disconnected. (Figure 2).

The total recoil energy is: m + MCAt= Q

here: MC At - this energy consists of heat given off by paraffin;

C - heat capacity;

When the cooling temperature is from 250 to 600 °C, the difference is 190°C.

On the example of the using paraffin, the efficiency of drying products is shown. The proposed drying device has a heat accumulator and a liquid heat carrier, and the temperature rises to 150-200°C within 1 hour after starting the heating system. Then the heating system is turned off and the taps are opened to circulate the coolant in the drying chamber. And this is fruit in the drying chamber and the vegetable dries up and the coolant passes from a liquid to a solid state. At the same time, at a temperature of 40-60°C, the FIC of the device reaches the highest level. Heat is supplied for 4 hours, the heating system starts up again, runs for 1 hour, and the process continues cyclically.

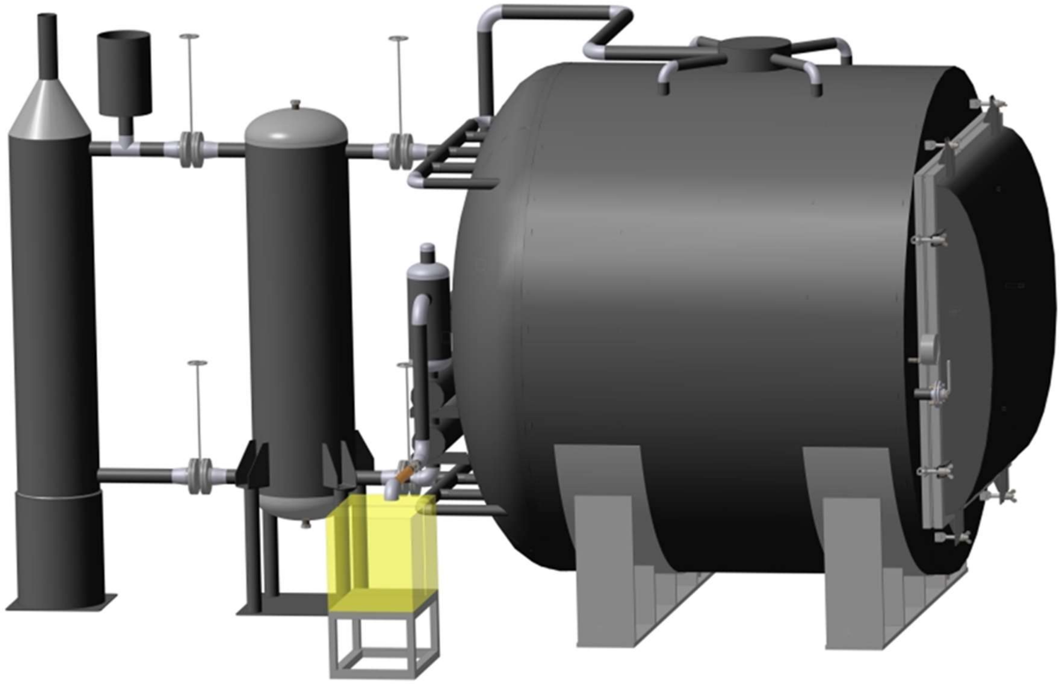

Figure 3. Vacuum drying device with heat accumulator and heat transfer fluid.

The distribution of heat rays when drying agricultural products, fruits and vegetables in a vacuum dryer with a heat accumulator reduces the drying time and improves the quality of the process.

The mechanization of the drying process of agricultural products, fruits and vegetables, research is underway to develop a processing technology using a vacuum dryer with a heat accumulator. An application has been submitted to the Intellectual Property Agency of the Republic of Uzbekistan for a utility model of a device for drying agricultural products, fruits and vegetables ("Drying Device" No. FAP 2021 0079) [9].

Conclusion.

1. The development and implementation of drying equipment allows us to increase the process of post-harvest processing and export of agricultural products, fruits and vegetables dehydrated, which in turn greatly contributes to the development of the agriculture and industry.
2. The technology and design of drying
agricultural products, fruits and vegetables using a heat accumulator has been developed. The heat accumulator can be used not only in a drying device, but also in greenhouses, industry, home heating systems and other industries.
3. Specifications, project documentation, as well as its scheme for the development of a heat accumulator, a liquid heat carrier and a vacuum drying device with thermal energy storage have been developed and approved. A new improved design of the heat accumulator, liquid heat

carrier and heat storage vacuum dryer has been developed. This design increases the energy efficiency of drying agricultural products, such as fruits and vegetables by 25-30%.

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