THERMAL TECHNICAL RESEARCH OF THE PROCESS OF DRYING MELONS SLICES IN A COMBINED DRYER

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Abstract: This article discusses the design features of a combined drying installation, the principle of its operation and the results of experimental studies of drying ring-shaped melon slices, as well as the dependence curves of the efficiency of the drying installation on the heating temperature of the chamber surface and at the outlet of the spent drying agent from the drying chamber. It has been proven that as the temperature of the spent drying agent increases, the thermal efficiency decreases. The optimal temperature of the heat release agent is considered to be .

Based on the analysis of the results obtained, recommendations are given for the use of a drying plant in farms and dehkan farms specializing in the cultivation and processing of melons.

Introduction

Drying of melon is carried out exclusively by farms and private farmsteads in rural areas, where the cultivation and cultivation of high-sugar varieties of melons is concentrated. These farms are located mainly in Khorezm, Bukhara, Samarkand, Syrdarya regions and the Fergana Valley. A common method for preparing dried melon is air-solar drying in the open air and solar-radiation drying system. However, they have disadvantages. Firstly, natural dust settles on the product and becomes contaminated by insects and flies, and secondly, the separated slices stick together, as a result of which the ventilation decreases and caramelization of natural sugars occurs, leading to the formation of melonoidins, rancidity and discoloration of the product. All this, of course, affects the quality of dried melon and reduces its taste and organoleptic properties [1,2].

The convective drying method has become widespread in industry. The comparative design of convective dryers is determined by the use of heated air, which is at the same time a drying agent, a heat transferr, a desiccant and a dehumidifier. The design and technological schemes of convective type drying installations are varied and developed taking into account the physical, biological and thermophysical properties of the material being dried. Dryers with an oscillating operating mode, which consists in changing the direction of coolant flow, are energy-efficient [1,3].

Object and methodology of research

Based on the assumptions made and taking into account the specifics of melon slices, we have developed a combined-type drying installation for drying melon fruits with an oscillating mode of heat supply, developed on the basis of the initial requirements [4] Fig. 1-2.

The device contains two parallel-arranged drying chambers with a rectangular cross-section, a fan, a main and auxiliary electric heater, an air distribution manifold with a V-

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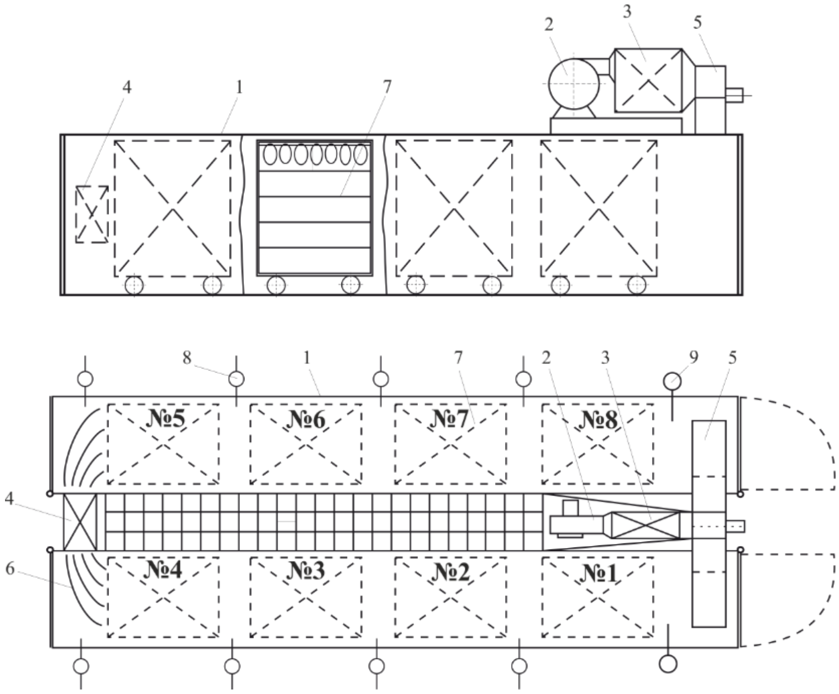
shaped vane valve. Inside the chambers there are curved air-guide ailerons and eight food carts located on corner guides (Fig. 1).

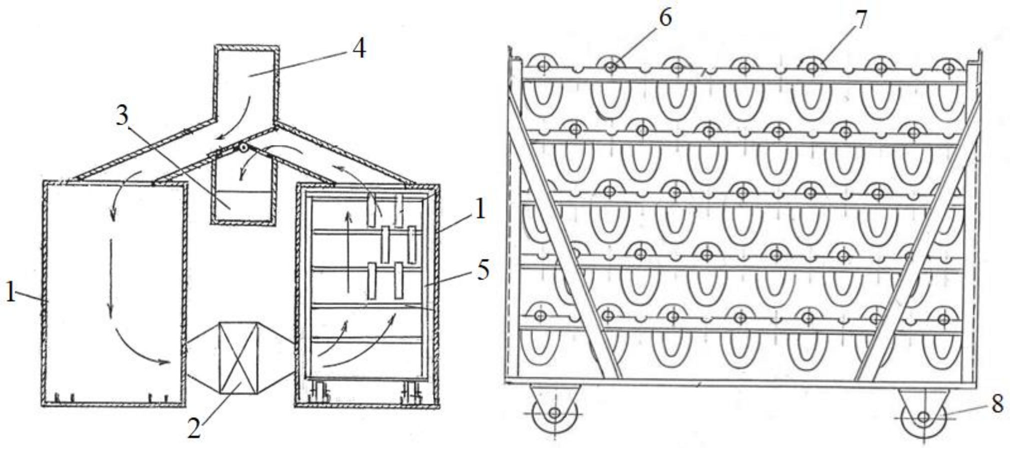


1 – camera; 2 – fan; 3, 4 – main and auxiliary electric heaters; 5 – air distribution manifold; 6 – ailerons; 7 – grocery carts; 8 – thermocouples; 9 – mercury thermometer

Rice. 1. Schematic diagram of the drying installation

The grocery cart is made in the form of a spatial parallelepiped, forming a rigid frame from an angle profile. On the longitudinal crossbars forming the tier, semicircular recesses are made for laying poles with melon slices, while the recesses are located on alternating crossbars, offset by half a step. Melon slices on poles are also stacked with mixing, placed in the volume of the cart in horizontal and vertical planes in a checkerboard pattern (Fig. 2).

The technological process of drying melon slices is as follows. Food carts with ring-shaped melon slices placed on poles are loaded into both drying chambers, the doors are tightly closed and the air and heat supply system is turned on: a fan and electric heaters. At the same time, the fan pumps air through the main heater, in which it is heated to 70-80ºC and through the air distribution manifold enters one of the drying chambers, in which it blows melon slices hanging on carts.).



1 – frame; 2 – electric heater; 3 – pipe;

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4 – air distribution manifold; 5 – grocery cart;
6 – wooden pole; 7 – a slice of melon; 8 – wheel

Rice. 2. Grocery cart for placing melon slices

The technological process of drying melon slices is as follows. Food carts with ring-shaped melon slices placed on poles are loaded into both drying chambers, the doors are tightly closed and the air and heat supply system is turned on: a fan and electric heaters. At the same time, the fan pumps air through the main heater, in which it is heated to 70-80ºC and through the air distribution manifold it enters one of the drying chambers, in which it blows on melon slices hung on carts. Due to convective heat exchange between hot air and the product, moisture evaporates and the air temperature drops.

Next, the air enters the intermediate heater, is heated to the required temperature and enters another chamber. Exhaust low-potential air with a temperature of 40-45ºC is discharged through one of the hoses of the air distribution manifold into the inter-chamber space, where poles can be hung for pre-withering the melon. By turning the V-shaped vane valve, the installation can be switched to an oscillating drying mode, which intensifies the moisture removal process. The oscillation period for drying melon is taken to be within 40-45 minutes.

As you know, the drying installation we developed operates on the heat of the main and intermediate electric heaters, as well as heat coming from solar radiation during the daytime. At night, part of the heat is compensated by the heat accumulated in the water jacket [1,4].

For the purpose of rational and energy-saving operation of the drying unit, modes are provided for regulating the power of electric heaters depending on the time of day, carried out by an automation system.

The proposed heat supply scheme allows for effective joint operation of solar and traditional (electric) heat sources with the recovery of low-potential energy from the exhaust air environment. Utilization of heat from the water jacket and heat-storing nozzle constitutes the economic component of the drying process.

The circuit works as follows. During the sunny daytime, air is sucked through the heat accumulator, partially heated and supplied through the main electric heater fan and the air distribution airlock device into the drying chamber, where the carts with the product are blown.

At night, the dryer operates using the heat of both electric heaters in active ventilation mode, while part of the heat is replaced by energy accumulated in the water jacket.

Practical results

To determine the beam-absorbing surface, we created a geometric model of the dryer made of foam plastic on a scale of 1:10 and using artificial lighting, taking into account the angle of incidence of sunlight for our latitudes φ = 39ºC, we determined the shading coefficient of the shape of the dryer. Measurements showed that the coefficient Kzat. = 0.67.

Then the useful beam-absorbing surface of a real dryer will be

$$F_{пол.}=F\cdot K_{зат.}=4{,}5\cdot 0{,}67=3{,}06\ м^2. \quad (7)$$

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In the summer-autumn months, for the latitude of the Mirzachul valley, the power of solar radiation is 800-1400 W/m2. In this case, energy is supplied to the surface of the water jacket in the amoun

$$tQ_{п.}=F_{пол.}\ q_{ср}=3{,}06\cdot1100=3376\ Вт=3{,}4\ кВт. \qquad (8)$$

During the daylight hours, with solar insolation lasting from 900 am to 1700 pm, 39.6 kWh of energy will be supplied. (For comparison: the installation capacity of the dryer from the Cacak company - Slovenia, is 125 kWh with a raw material capacity of 1.5 tons / day) [6,7].

To study the change in water temperature in the jacket and inside the chamber itself along the length of the dryer, we measured temperatures at seven control points with a KPS-4 potentiometer and at five points with mercury thermometers throughout the day every hour.

It was noticed that during the daytime, over time, the temperature of the accumulating water in the jacket increases from tн=30 ºC to tк=65 ºC due to the absorption of solar radiation. The air temperature in the rising part of the drying chamber also changes slightly due to heat transfer through the walls of the water jacket.

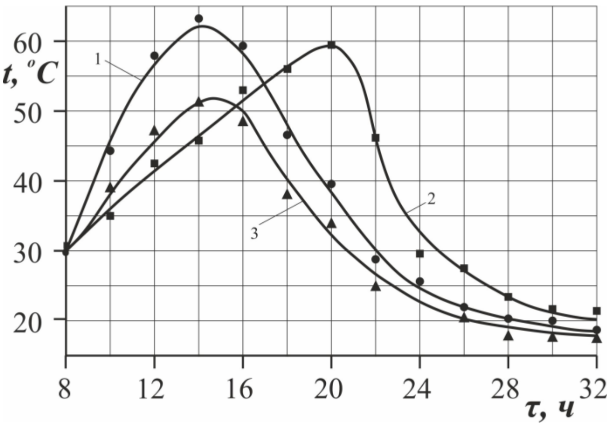
After sunset, starting from 2000 hours, these temperatures drop due to the discharge of the water accumulator. By 1800 hours the difference between the heated air (upper point) and the incoming air (lower point) is respectively 15ºC (charging period), and by morning 600 hours (discharging period) -

3ºC. The average temperature inside the chamber varies from 30ºC to 65ºC. During the energy accumulation period, 2.84 m3 of water (jacket volume) accumulates

$$Q_{п.}=G_{в}\cdot c_{в}(t_{к}-t_{н})=2{,}84\cdot4{,}19\cdot10^{3}(65-30)=11900\ кДж\ тепла. \qquad (2.48)$$

After 2000 hours the battery discharges.

Graphs of changes in water and air temperatures, as well as accumulated energy during drying, are shown in Fig. 3.



1 – air temperature in the drying chamber; 2 – water temperature in the jacket drying chamber; 3 – temperature of accumulated energy in the drying chamber

Rice. 3. Graphs of changes in water and air temperatures and the temperature of accumulated energy in the drying chamber

The analysis showed that due to the natural circulation of water inside the jacket, depending on the mode of movement (Reynolds and Grashof criteria), the temperature of the liquid at the top and bottom of the chambers, as well as along the length of the chambers, varies greatly. To eliminate this negative effect, it is necessary to create forced water circulation by installing an external recirculation loop, including centrifugal pumps and pipelines.

Conclusion

Thus, it can be stated that the developed new design of the chamber-convective drying unit has provided high technical and economic indicators for drying ring-shaped melon slices, as well as its feasibility of use in small and medium-sized farms specializing in the production of dried melon.

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