Technical science and innovation

Volume 2023 | Issue 4 Article 13

1-10-2024

# IMPROVEMENT OF CONVECTIVE DRYING EQUIPMENT

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## Recommended Citation

Ponasenko, A; Safarov, Jasur; and Sultanova, Shaxnoza (2024) "IMPROVEMENT OF CONVECTIVE DRYING EQUIPMENT," *Technical science and innovation*: Vol. 2023: Iss. 4, Article 13.
DOI: https://doi.org/10.59048/2181-0400
E-ISSN: 2181-1180
.1535
Available at: https://btstu.researchcommons.org/journal/vol2023/iss4/13

5. The diffusion of the solvent (water) occurs from an area with a higher partial pressure (lower concentration of the solution) towards a lower partial pressure (higher concentration of the solution). As a result of this process, osmotic pressure arises – a force that causes the diffusion of molecules.

6. Osmotic bound moisture is located inside the cells as if in a semipermeable pouch, does not differ from ordinary water, moves inside the material during drying without phase transformation in the form of a liquid. The process of removing this moisture from the cells is similar and opposite to its osmotic penetration into the cells.

7. Water in microcapillaries differs from free water by lower viscosity and surface tension and greater heat capacity. The freezing point of such moisture is less than 0°C.

8. Mechanically bound moisture practically does not differ from the properties of free water, it can be considered as free moisture, which is easily removed during drying in the first place.

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# IMPROVEMENT OF CONVECTIVE DRYING EQUIPMENT

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Received: December 23, 2023; Accepted: January 10, 2024; Online: January 16, 2024.

***Abstract.*** *Drying of agricultural raw materials is an energy-consuming but integral process. Therefore, increasing the efficiency of drying and improving the quality indicators of dried material at minimum material and energy costs is relevant for producers of agricultural products. By present time numerous researches on improvement of constructions and processes of work of dryers providing satisfactory parameters of energy saving have been carried out. In some scientific materials it is shown that the use of generative gas and straw as fuel allows to reduce energy costs for the drying process in the fluidised bed dryer by 10-30%, the quality of seeds was not taken into account.*

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*Convective dryer showed that simultaneous use of microwave and convective methods of drying wheat seeds allows to increase the drying rate, but the percentage of germination of wheat seeds decreases depending on the increase of power.*

***Keywords**: convective drying, plant, temperature, slope, diffusion, air velocity, numerical analysis, constants.*

***Annatatsiya.** Qishloq xoʻjaligi xom ashyosini quritish energiya sarflaydigan, ammo ajralmas jarayondir. Binobarin, quritish samaradorligini oshirish va quritilgan materialning sifat koʻrsatkichlarini minimal moddiy va energiya sarfi bilan yaxshilash qishloq xoʻjaligi mahsulotlarini ishlab chiqaruvchilar uchun muhim ahamiyatga ega. Bugungi kunga qadar qoniqarli energiya tejash parametrlarini ta'minlaydigan quritgichlarning konstruksiyalari va ishlash jarayonlarini takomillashtirish boʻyicha koʻplab tadqiqotlar oʻtkazildi. Ba'zi ilmiy materiallar shuni koʻrsatadiki, yoqilgʻi sifatida generativ gaz va somondan foydalanish suyuq qatlamli quritgichda quritish jarayoni uchun energiya sarfini 10-30% ga kamaytirishi mumkin, urugʻlarning sifati hisobga olinmagan. Konvektiv quritgich bugʻdoy urugʻini quritish uchun mikrotoʻlqinli va konvektiv usullarni bir vaqtda qoʻllash quritish tezligini oshirishi mumkinligini koʻrsatdi, lekin bugʻdoy urugʻining unib chiqish foizi quvvatning oshishiga qarab kamayadi.*

***Kalit soʻzlar:** konvektiv quritish, oʻrnatish, harorat, nishab, diffuziya, havo tezligi, raqamli tahlil, konstantalar.*

***Аннатация.** Сушка сельскохозяйственного сырья – энергозатратный, но неотъемлемый процесс. Поэтому повышение эффективности сушки и улучшение качественных показателей высушенного материала при минимальных материальных и энергетических затратах актуально для производителей сельскохозяйственной продукции. К настоящему времени проведены многочисленные исследования по совершенствованию конструкций и процессов работы сушилок, обеспечивающих удовлетворительные параметры энергосбережения. В некоторых научных материалах показано, что использование генеративного газа и соломы в качестве топлива позволяет снизить энергозатраты на процесс сушки в сушилке с кипящим слоем на 10-30%, качество семян не учитывалось. Конвективная сушилка показала, что одновременное использование микроволнового и конвективного способов сушки семян пшеницы позволяет увеличить скорость сушки, однако процент прорастания семян пшеницы снижается в зависимости от увеличения мощности.*

***Ключевые слова**: конвектив сушка, установка, температура, наклон, диффузия, скорость воздуха, численный анализ, константы.*

## Introduction

The developed convective drying plant operates with minimum energy consumption, as well as controls the drying process by regulating the supply of hot air and with increasing the efficiency of work due to its volume and accelerating the drying process with the preservation of biologically active substances in the final product. Let us consider a convective drying plant for drying agricultural products of capillary-porous origin.

## Material and Methods

The apparatus operates as follows. In the trolley 8 pallets with stainless mesh bottom 9 with cleaned and prepared for drying raw materials 15 are placed. With open doors 2 in the container-convective drying chamber 1 raw materials are loaded by trolleys 8. Tightly close the doors of the installation with the latch 7. Switch on the gas burner device 4, which goes hot air with the help of valve 12, which is distributed from nozzles 11 through pipes 5 on the area of the chamber [1-2].

The supplied hot air passes through the heat-conducting pipes 5, heating the inner chamber thereby and the raw material intended for drying. The accumulated vapour from evaporation of moisture from the raw material is discharged by means of fans 3 and 13 through exhaust pipes 14. In order to ensure a uniform heat flow, a recirculation fan 16 operates in the chamber. Recirculation of the heat agent between the pallets ensures uniform heating of the raw material. In the drying process the heat agent is controlled by a thermoregulator and does not allow the air flow to overheat the raw material from the set temperature [1-3].

A special container-type drying plant operates on natural gas (or coal, wood, briquettes, electricity, oil products) by means of a gas burner. It is known that from 1 $m^3$ of gas it is possible to get 34,02 MJ of energy or 9-10 kWh. Fuel consumption for drying of raw materials - flowers is 7 $m^3$ of gas at 4-5 hours of work, for fruits and tubers 15 $m^3$ of gas at 8-10 hours of work is consumed, also for drying of grass 4 $m^3$ of gas at 2-3 hours of work is consumed. If electricity is used for drying the above-mentioned products, 36 kWh will be consumed for each hour of work [4].

The heat transfer medium is led into the container type dryer by a line of heat-conducting pipes. Metal tubes and withstand the prolonged exposure to the active elements released from the product during the drying process. Each heat-carrier pipe is equipped with manifolds with flanges for connection to the furnace boiler. The heat carrier pipes are fixed to the drying chamber frame by means of special fasteners. Circulation of the heat agent - hot air is carried out with the help of fans according to the laws of physics spontaneously, as a rule, hot air rises from bottom to top, as the furnace boiler is located at the bottom of the container - dryer.

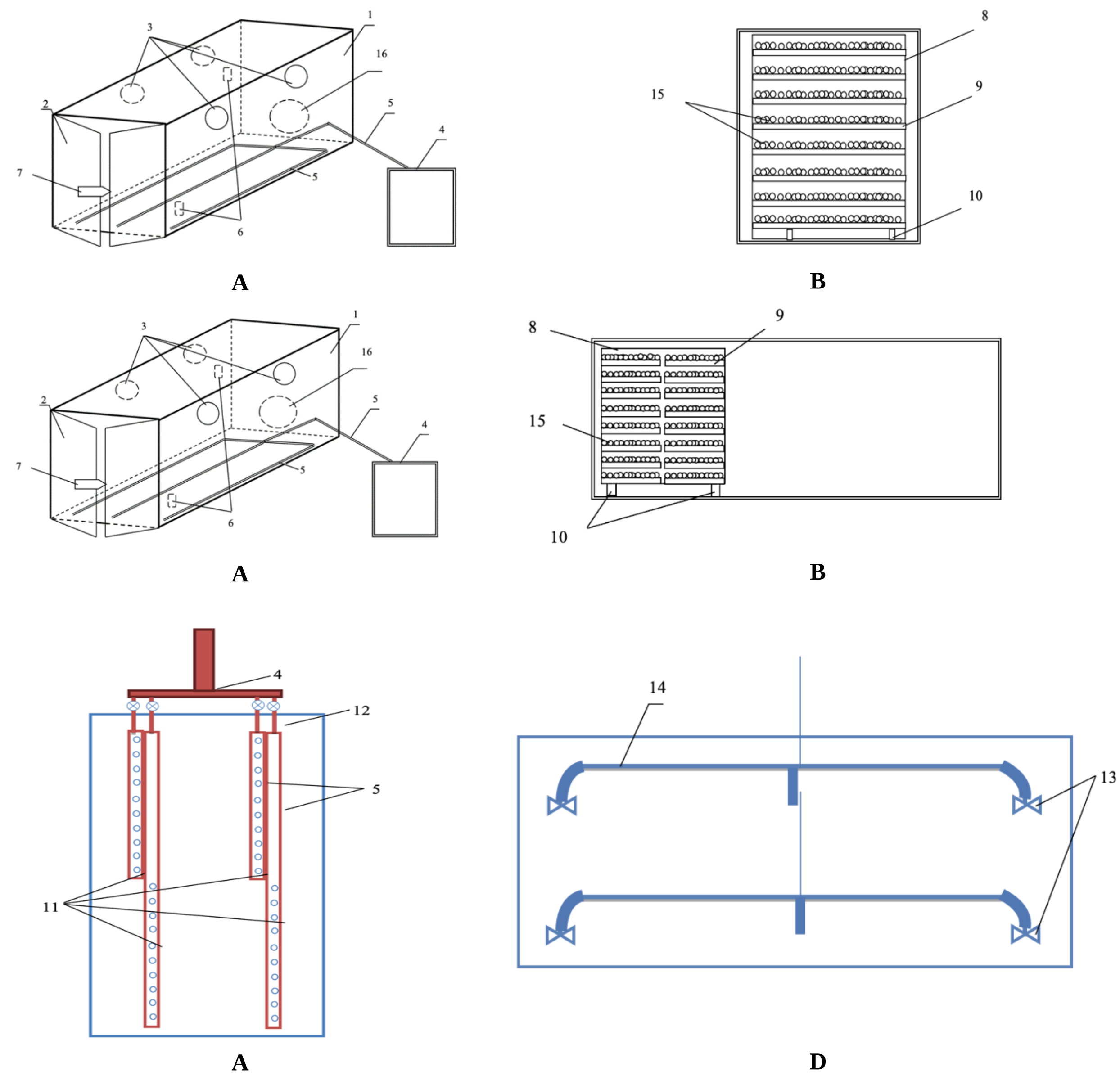


**Fig.1. 2-door; 3-fan; 4-gas burner; 5-heat carrier; 6-sensors for temperature determination in the chamber; 7-valves; 8-trolley; 9-pallets with stainless mesh bottom; 10-wheels; 11-nozzle; 12-valves for gas supply control; 13-upper fans; 14-exhaust pipes; 15-raw material; 16-fans for air circulation; 17-boilers.**

Fig.1. Principal scheme of convection drying plant: A - main view; B - front view; C - side view; D - layout of heat pipes from above; E - layout of exhaust pipes.

## Results and Discussion

To intensify the drying process, air circulation can be forced by providing sufficient air exchange inside the target container chamber using a fan. A fan is installed to the bottom of the dryer container to supply air. The circulation volume of each fan is 780 $m^3$ /h, depending on the total air circulation volume per chamber it is 1560-6240 $m^3$ /h [4-5].

The air exchange fans are located on the side (can be roof-mounted if necessary) of the drying chamber to direct the air flow and serve to maintain the air exchange between the chamber and the environment [6].

Container convective drying plant contains removable drying chambers with pallets with dimensions 800x1000x50 mm, 16 pieces are arranged vertically on each trolley. The usable area per pallet with a grid bottom is 0.8 $m^2$. The distance between pallets is 200 mm. The trolleys are moved along the chamber with the help of small wheels [5-7].

After loading the raw material into the chamber, the furnace nozzle is ignited and the air temperature in the dryer is raised to 55-65 °C. In order to maximise the preservation of the final product during the drying process, the temperature is maintained automatically by means of a thermoregulator located in the chamber.

The intervals of loading and unloading of products depend on the duration of drying of raw materials. For example, as a raw material, flowers are dehydrated for 4-5 h, if fruits and tubers - 8-10 h, and also if herbs - 2-3 h.

With controlled hot air blowing with fans and drying temperature, the layer-by-layer distribution of beneficial substances is faster and of higher quality [8-10].

The essence of the useful model consists in the fact that the plant takes into account the adsorption properties of substances saturated drying products, that is, determine their own adsorption and desorption rates of substances in the wet state, in accordance with which set the mode of drying the product. As a result of such drying, a product with layer-by-layer distribution of substances contained in the product is obtained, which allows to maximally preserve useful biologically active substances of products [9-10].

Thus, the advantage of the proposed unit is that using the proposed unit it is possible to obtain drying products enriched with substances dissolved in fresh fruits and vegetables, with a predetermined distribution over the volume of the product. That is, as a result we get a product with predetermined properties. Another distinct advantage of the proposed plant is the use of a container to increase the efficiency of the drying process and the use of natural gas or solid fuel. In addition, low-temperature dehydration of products allows to maximally preserve useful biologically active substances of final products [11-13].

The proposed developed container-convective drying plant is economically efficient by reducing the loss of raw materials and increasing the productivity, also gives the opportunity to preserve biologically active substances in the final product.

## Conclusion

Convection drying has been experimentally investigated. In the study, drying experiments were carried out under different air conditions and the data obtained are presented in graphs.

From the experiments, it was observed that as the temperature and drying air velocity increased, the drying rate increased and the drying time decreased. The shortest drying time was at 70°C and air velocity of 2 m/s. The products changed size, shape and colour during the drying process. Shrinkage and colour change did not occur simultaneously under different drying conditions. Colour lightening of the product occurred 30 minutes after the start of the drying process at 60°C, 5% relative humidity and 1 m/s air velocity. After 45 minutes, a change in shape occurred (buckling at the edges of the product). After 60 minutes, deformation occurred, starting from the centre of the product, and after 105 minutes, noticeable hardness and brittleness occurred in the product.

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