# Development Solar Water Heater Drying Equipment For Drying Medicinal Plants

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***Abstract***
*The proposed development is based on a change in the physical nature of the mechanism for removing the liquid contained in the product and entails saving (several times) in the energy consumption of technological equipment due to the sale of natural gas and solar energy. When using this technique and technology, there is no need for energy consumption for heating coolants, medicinal plants, and structural elements of the drying chamber.*
***Keywords.*** *solar drying, water heater, medicinal plants (herbs).*

**Introduction.**

In the world, the development of the pharmaceutical industry pays great attention to the study of the process of preparation and processing of medicinal herbs. In this regard, applying advanced modern technologies of processes and apparatuses for processing medicinal plants, devices have been developed for producing high-quality pharmaceutical raw materials and biologically active substances, energy-saving drying techniques and technologies have been introduced into the industry for drying raw materials, and a drying plant for drying medicinal plants developed on the basis of scientific evidence [1-5]. At the same time, it is of great scientific and practical importance to create a rational design of a drying plant that works without electricity and use innovative methods to preserve the medicinal properties of plants, taking into account the thermophysical properties of raw materials.

Medicinal plants include those plants that are used to treat people and animals or are used as raw materials for the production of drugs. At present, about 270 plant species are used for these purposes: 150 species are used as raw materials for the pharmaceutical industry, about 90 plant species are sold for initial processing, and natural compounds are isolated from the rest [6-11]. More than half of the entire range of harvested medicinal raw materials are wild plants. Such raw materials include dried whole plants and their individual parts - buds, leaves, flowers, stems, tubers, bark, roots and rhizomes [12-18].

Drying naturally takes too much time. Now this method of processing medicinal raw materials is extremely rare. At most medium and large enterprises, special equipment is used for these purposes, which also has several drying modes. For each type of plant, you can choose your temperature and processing time. Well-dried plant materials should contain no more than 12-15% hygroscopic moisture [19-23].

Factors that significantly intensify production include mechanization, including the use of drying equipment. The use of drying equipment creates the prerequisites for harvesting without loss under any weather conditions and without compromising product quality. Therefore, the widespread use of drying equipment to a large extent determines the level of industrial production of products.

**Results and discussion research.**

The developed solar water heating dryer is designed for food and pharmaceutical companies to produce high-quality products - dried and concentrated extracts of vegetables, fruits and herbs, as well as syrups, mashed potatoes and dry concentrates with the preservation of biologically active substances and healthy ingredients based on local raw materials [24 -27].

The dryer is designed for operation in the field at ambient temperatures from + 20 ºC to + 60 ºC.

The dryer is designed to operate under the following conditions:

a) working position - should be installed on a solid horizontal platform that anticipates rolling down;

b) control nodes - it is necessary to provide with free access;

c) to guarantee the implementation of technological and technical maintenance - it is necessary to provide free space and appropriate lighting.



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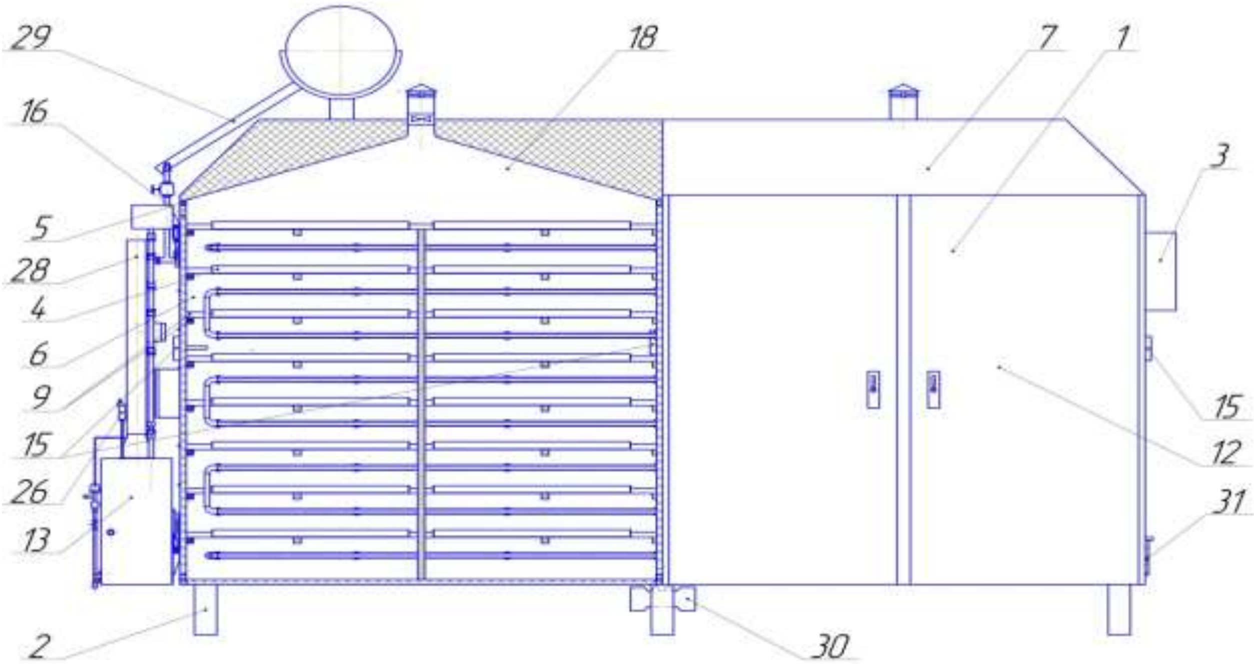
The design of a solar water-heating convective installation makes it easy to transport due to the installed wheels. Also, if necessary, can be transported using a tow truck.

The scheme of a solar water heating convective installation is shown in fig. 1.

The proposed solar water heating drying equipment is shown in Fig. 1 and consists of a drying chamber 1, a unit foot 2, an integrated control panel with a current inventory 3, a pallet for processed raw materials 4, a chamber frame 5, an inner grid 6, an outer lining 7, a ventilation pipe 8 , tier with limiter 9, bracket for attaching the irradiation unit 10, the irradiation unit of infrared radiation 11, the door 12, the heating boiler 13, the gas boiler 14, the thermometer 15, the heat-insulating layer 16, the steering wheel for locking the door 17, int the ceiling of the chamber 18, the automatic device of the burner 19, the expansion barrel 20, the system of heat exchangers 21, ball valves 22, pipelines 23, the door of the heating boiler 24, the heat of the battery 25, steam vent (air vent) 26, circulation pump 27, chimney (gas duct) 28, solar collector 29, vibrator 30, vents 31.



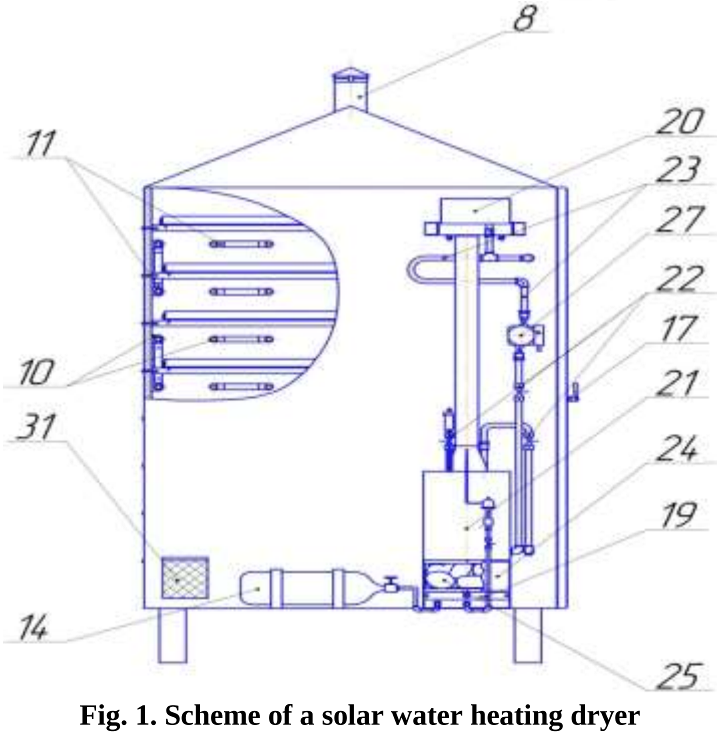




**Fig. 1. Scheme of a solar water heating dryer**



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1-drying chamber; 2-legs installation; 3-built-in control panel with current inventory; 4-pallets for recyclable materials; 5-frame camera; 6-inner mesh; 7-outer cladding; 8-vent pipe; 9-tier with limiter; 10-bracket for attaching the irradiation unit; 11-irradiation unit of infrared radiation; 12-doors; 13-heating boiler; 14-gas boiler; 15-thermometer; 16 heat-insulating layer; 17-helm locking the door; 18-inner chamber ceiling; 19-automatic burner device; 20-expansion barrels; 21-heat exchanger systems; 22-ball valves; 23-pipelines; 24-door boiler; 25-heat battery; 26-steam vent (air vent); 27-circulation pump; 28-chimney (chimney); 29-solar collector; 30-vibrator; 31-holes for ventilation.

For this convective drying installation, technical specifications and specifications for serial production have been developed.

As a result of studies of a convective drying plant for processing medicinal plants, an existing industrial plant was developed.

The solar water heating dryer for drying medicinal plants and fruits (Fig. 1) is a combination of structures of component parts of the equipment, consisting of:

1) a drying chamber;
2) installation chassis;
3) built-in control panel with current inventory;
4) 16 pallets with a mesh bottom for processed raw materials;

The drying chamber consists of the following main units:

- camera frame;
- inner wall;
- outer cladding;
- vent pipe with umbrellas;
- tiers from a rolling profile with a limiter;
- brackets for attaching the irradiation unit;
- irradiation unit of infrared radiation;
- two doors to the peridium of the chamber;
- a universal heating boiler heated by gas (or solid fuel);
- gas bottle;
- pressure reducer;
- sleeves (hose) of a high pressure in a set;
- a thermometer;
- battery;
- a heat-insulating layer between the inner wall and the outer lining;
- brackets for fixing the heating boiler and expansion barrel;
- an arm for attaching a gas cylinder;
- steering wheel to lock the door.

The inner wall of the chamber ceiling is made in the form of two umbrellas (a rectangular truncated pyramid with a wall thickness of 2 mm).

The infrared radiation unit consists of metal pipes. Doors consist of:

- door frame;
- inner wall;
- outer cladding;
- loops;
- locking bracket.

Steam-water heating device consists of:

- water heating boiler;
- automatic burner device;
- expansion barrel;
- heat exchange systems, pipelines and ball valves;
- heat of the battery (fireplace);
- automatic steam vent (air vent);
- circulation pump;
- chimney (flue).

Flat solar collector.


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**Conclusions.**

Drying of medicinal plants by methods known today requires high energy costs. This leads to the fact that the cost of quality drying exceeds the cost of medicinal plants. The proposed development is based on a change in the physical nature of the mechanism for removing the liquid contained in the product and entails saving (several times) in the energy consumption of technological equipment due to the sale of natural gas and solar energy. When using this technique and technology, there is no need for energy consumption for heating coolants, medicinal plants, and structural elements of the drying chamber.

We proceed to calculate the economic efficiency of the introduction of a solar water heating dryer for high-quality drying of medicinal plants with a high content of biologically active substances. The main principle underlying the assessment of the effectiveness of an innovative object is the comparison of the expected integrated results and costs with an orientation towards achieving the required rate of return on capital.

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