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TECHNICAL EQUIPMENT USED FOR COTTON DRYING. CONSIDERATION OF THE OPERATION PRINCIPLE OF THE MICROWAVE DRYING INSTALLATION

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Abstract: This article examines the devices used in cotton drying and examines their operating principle. As an example, the operating principle of a microwave drying unit is examined in detail.

Keywords: drying, microwave technology, molecules, infrared radiation, short-wave radiation, heat and mass exchange, "Arabis-M12" brand installation, product, relay control, antioxidant powders, water energy, electromagnetic field, low temperature, technology, but special attention.

Microwave technology is a high achievement of science and technology, the result of many years of work by scientists and specialists in the military-industrial sector. In world practice, such an experience had practically not existed before. With the help of microwave equipment, one can indeed solve pressing production tasks—drying fruits and vegetables, grain, timber, bricks, leather, cotton, and medicinal plants; improving the quality of livestock feed; and obtaining chemical substances from plants.Using microwave technologies and equipment, one can not only dry products but also obtain food dyes and defrost frozen fish, meat, fruits, and vegetables.

During this method of drying, the molecules begin to oscillate and rotate. The movement of molecules represents thermal energy. The more water there is in the material, the more actively the molecules move and the more thermal energy is released. Thus, heating occurs in all parts of the product, while the moister areas receive more energy.As a result, moisture evaporates, the product dries, and moisture is distributed evenly. When humidity decreases, the drying process does not slow down, as the heat transfer mechanism does not play a primary role. Microwave drying of cotton requires little time, and the temperature during the process remains relatively low, which contributes to the preservation of essential vitamins in the product. The energy source of the microwave generator is electricity, which ensures the environmental purity of the product. The only disadvantage is the conversion of energy efficiency into microwave energy in microwave equipment.Therefore, the humidity level when using microwave equipment must be below 50%. It should be noted that under the influence of the microwave field, the microflora is completely destroyed, which ensures the long-term preservation of product quality and increases the efficiency of using microwave equipment in production. Microwave drying is characterized by high quality and process speed. This method of drying also does not have a negative impact on the environment. Currently, microwave dryers are used in the following areas.

"Arabis-M12" microwave unit.

The tunnel-type "Arabis" microwave equipment is designed to improve the microbiological indicators and increase the shelf life of various products, such as cotton, grain, and other materials. The operating mode is cyclic, control is based on a relay system, and the main temperature regimes range from 60 to 300 degrees.The product is fed to the inlet of the unit using a conveyor. The time for primary treatment and the subsequent processing process depends on the selected mode, as all processes are regulated by the control system. The device's housing is made of stainless steel and is designed for processing cotton products. The standard dimensions of the working chamber are 450 × 350 mm.Raw material processing productivity, depending on the initial and final moisture content of the product, as well as the processing mode, can reach up to 700 kg per hour.



Figure 1. "Arabis-M12" microwave unit.

Infrared light drying device

Modern environmentally friendly drying technology is based on infrared rays and is safe for the environment and human body. The density of infrared waves eliminates harmful microbes in dried products and ensures the preservation of product quality for a long time.Drying a product using infrared rays allows for drying a large amount of product in a short period of time.Infrared light drying device. Currently, this is one of the most widely used methods, occupying a leading position in the industry. In infrared radiation, there is a rapid movement of molecules and atoms under the influence of productive radiation, i.e., an increase in internal energy. During cotton drying, the exposure thickness of infrared rays is 6-12 mm. At this thickness, a small amount of radiation energy is consumed, but the temperature of the material layer placed at an interval of 6-7 mm increases significantly compared to the convective method.The impact of short-wavelength infrared rays on cotton acquires greater force of action, as they reach the molecular structure. The process of drying with infrared rays is also widely used in industry, where many types of vegetables and fruits, meat, and fish are processed, and many types of semi-finished products are manufactured. In addition, powders dried under infrared rays are antioxidants. Products dried in an

infrared dryer can be stored for up to a year without special containers, and in this case, 5-15% of vitamins can be lost. Dried products in airtight containers can be stored for up to two years.During drying, the shape is reduced by 3-4 times. Weight may decrease 4–8 times. However, not only the dried product but also special instruments operating in this manner and subjected to infrared and technological processes deserve attention. Using infrared drying technology, it uses 100% energy relative to the product. The water molecules in the product absorb infrared rays, and their chaotic movement begins to accelerate; that is, unlike other types of drying, energy will be directed toward the water. Such drying has two advantages:

1. Cells are not damaged, vitamins are preserved, and sugar does not thicken;
2. At low temperatures, heat is retained in the product.

At the same time, infrared rays at 40-600°C destroy all microbeads on the product shell, and then the product becomes clean. In the infrared range, the vibrating dryer transmits energy to a layer that oscillates in the electromagnetic field. The process of energy transfer to the product in an electromagnetic field improves product quality, creates favorable conditions for process automation, and accelerates the heat exchange process due to the density of a large amount of heat and partial energy input. The essence of the process is that the product melts, releases, and takes on the desired shape under the influence of oscillations. All parts of the product are treated with infrared rays, which come from quartz halogen lamps. Due to the high density of the heat flow and its penetrating properties, the product heats up and dries quickly. To accelerate the heat and weight exchange process, drying is carried out in an oscillatory mode, and air heating is provided in heat-producing zones. The supply of hot air to the drying zone creates a process of convective heat and mass exchange and facilitates and accelerates the removal of steam. Due to this process, drying efficiency, quality, and product quality indicators increase. In strip dryers, the heat treatment process occurs in the stationary layer of the product, resulting in uneven heat and moisture distribution, which reduces the quality of the finished product. In belt dryers, there is transportation involving a metal type or a rubber belt. This type prevents the processing of fine-dust products, and the rubber tape cannot transfer heat.

Vibratory drying devices with infrared radiation have no such disadvantages, as their transport part consists of steel trays into which wheat and powdered products can be placed at the required speed, and the processing rate can reach 2500°C. In such dryers, the horizontal vibratory conveyors (1) are in the form of a rectangular groove (2) with its working parts made of stainless steel. In the upper part of the tray, there are infrared beam cassettes (3), steam release sections (4), and product freezing sections (5). The initial part of the groove is heated through a cassette located at the bottom. Each infrared beam cassette is equipped with a fan that allows the lamp to pass through and also dries the hot air into the drying zone. The cassettes and sections are located on circular rods.

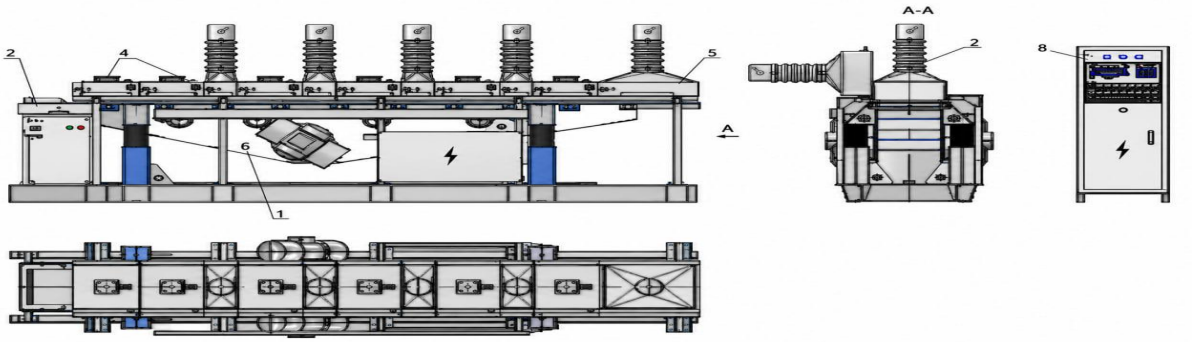


Figure 2. Vibratory infrared dryer.

1 - vibration conveyor, 2 - tray, 3 - IR emitter cassettes, 4 - steam release section, 5 - product cooling section, 6 - fan, 7 - flexible air duct, 8 - control panel.

The steam outlet and freezer sections are connected by a flexible air duct (7). The product entering the dryer is placed in a tray under the influence of vibration, then passes through cassettes and steam exhaust sections. Infrared rays, passing through the layer, transform into thermal energy, heat the product, and evaporate moisture from it. Steam entering through the fan passes through the channels inside it, cools the lamp contacts, heats them, and enters the drying zone, thereby ensuring convective heat and mass exchange and the process of steam release.The release of moist air is carried out through the steam exhaust section using a exhaust fan. The transportation speed of the product and its processing time are regulated by changing the rotation speed of the vibration. The heat level in the tray under the cassette is monitored by contact thermocouples, and the heat level of the product leaving the dryer is monitored by pyrometers. The power supply set includes a control cabinet (8), a steam release system, and refrigeration systems (ventilator, flexible air ducts, overhead covers).

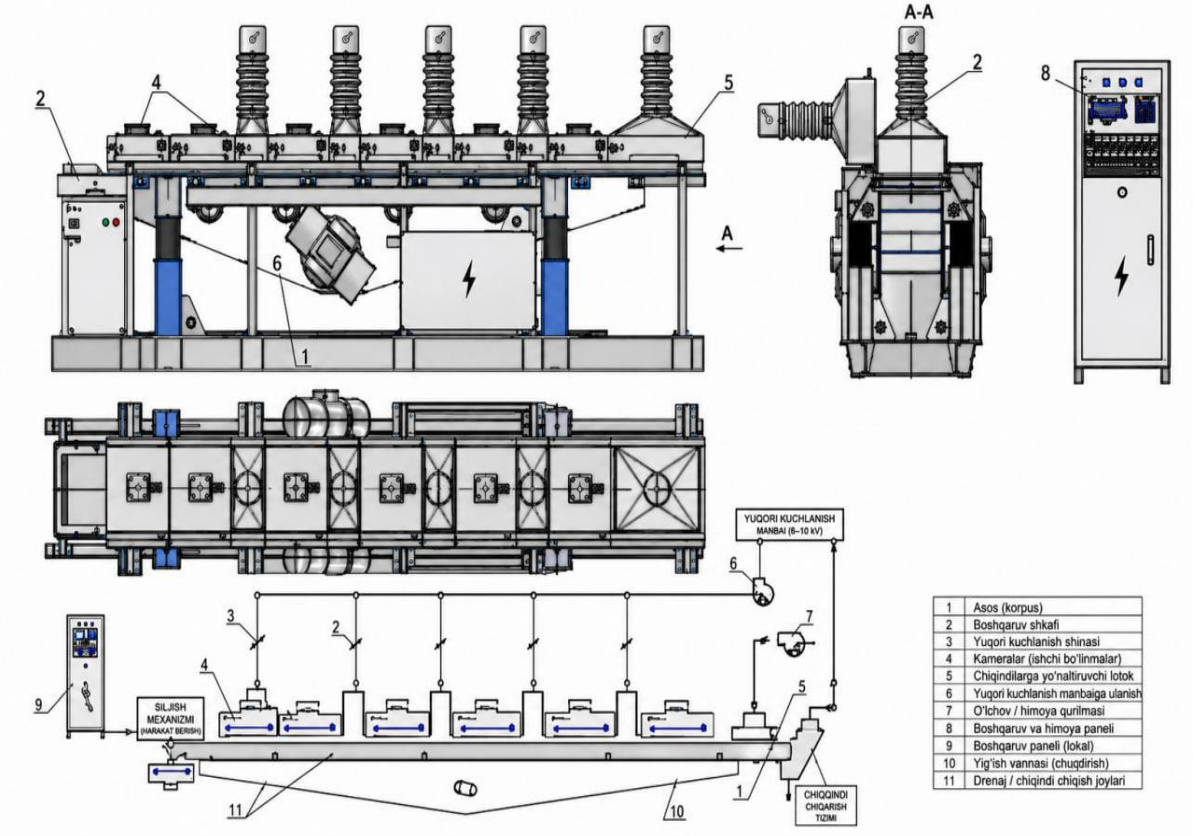


Figure 3. Technological diagram of the SVIK-350 brand dryer:

1 - vibratory conveyor, 2 - infrared radiation cassettes, 3 - steam exhaust sections, 4 - product freezing section, 5 - hopper, 6 - steam exhaust fan, 7 - product freezing fan, 8 - partition, 9 - air duct, 10 - control panel, 11 - thermocouple, 12 - temperature control pyrometer.

The control and control system of the dryer ensures the switching on (off) of equipment, manual and automatic control, control, the specified technological operating mode, equipment shutdown in unfavorable situations, and the use of signaling during malfunctions.

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