UDC 621.365.55
IRSTI 44.29.01, 44.29.39 *DOI 10.56339/2305-9397-2022-3-3-226-231*

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POWER SUPPLY OF MICROWAVE INSTALLATIONS OF CONVEYOR TYPE FOR DRYING POOL MATERIALS WITH RENEWABLE ENERGY SOURCES

ANNOTATION

Currently, there are a large number of territories in the Republic of Kazakhstan that are not connected to centralized networks. Power supply of objects in such territories is a complex task, the solution of which requires significant material costs. The use of microwave technologies is a promising direction in the processing of agricultural products. In the context of the development of farms located at a considerable distance from centralized power supply networks, the development and creation of microwave installations with autonomous power supply is an urgent task. In the context of the development of farms located at a considerable distance from centralized power supply networks, the use of renewable energy sources is the most effective solution. The article discusses the design features of a microwave installation for drying bulk materials, in which the required technological regime is provided by controlling the power of magnetron microwave generators and the speed of movement of the processed products.

Key words: *conveyor-type microwave unit, microwave dryer, magnetron, power supply system, power control, wind generator, solar panel.*

Introduction. Microwave dielectric heating makes it possible to effectively implement a wide range of technologies [1]. The main advantages of using microwave heating in thermal processes are due to the peculiarities of its absorption. Microwave energy is converted into heat within the substance, resulting in significant energy savings and reduced process times. The main areas of application of microwave heating are the food, woodworking, rubber, textile, and pharmaceutical industries [2]. A large number of microwave devices are used, in particular, for the heat treatment of agricultural products and foodstuffs, which usually contain a lot of water and therefore absorb microwave energy well [3,4].

The processing of materials using microwave energy shows many promising advantages over conventional heating technologies, such as improved product quality, reduced process control time, energy savings due to higher efficiency, reduced environmental pollution, lower equipment costs and higher installation flexibility [1].

In connection with these advantages, the number of electro technological microwave installations is constantly growing both in everyday life and in industry [2,3]. Therefore, there is a need to create efficient, improved electro technological microwave heating installations, as well as reliable power supplies for these installations [5,6].

There are various designs of electro technological microwave installations. For drying bulk materials, microwave installations of a conveyor type have certain advantages, in which microwave energy is distributed throughout the volume of the installation due to the use of several generators of microwave oscillations [5].

The proposed design of such an installation is shown in figure 1. The setup contains six beam-type chambers equipped with six TOSHIBA E3328 magnetrons with a nominal output power of 3 kW [6]. These magnetrons operate at a frequency of 2450 MHz, which is excellent for processing bulk materials such as grains, fruits, vegetables and herbs. Each microwave generator has its own independent from other power sources. Such an organization of power supply allows the installation to operate uninterruptedly even in the event of failure of one or two magnetrons [7,8].

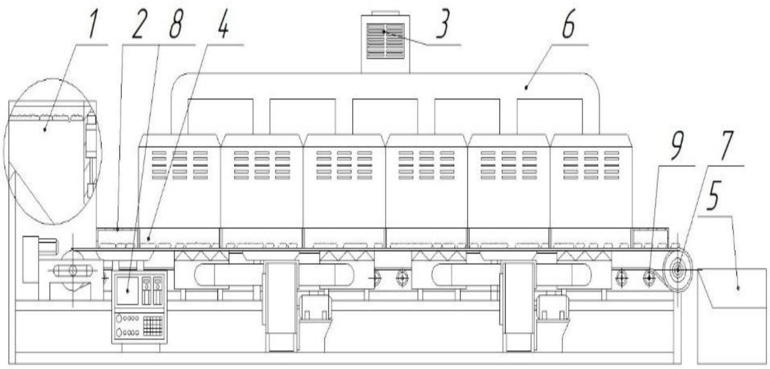

Figure 1 - The design of the conveyor-type microwave installation

1 - system for delivering material to a conveyor belt; 2 - system of protection against microwave radiation; 3 - ventilation system; 4 - processed material; 5 - system for receiving from a conveyor belt; 6 - ventilation pipes; 7 – conveyor belt drive; 8 – installation control system; 9 - rollers-tensioners of the conveyor belt

Objects and methods of research. The belt conveyor consists of a closed traction element (tape), which is also a working element that moves along movable roller bearings and goes around the guides. The upper branch of the belt, on which the load is located, moves along the fixed corrugated roller bearings. The lower part of the belt (idle) moves on straight roller bearings 9. The belt is driven by a drive drum 7 connected to an electric motor. During processing, the processed material is continuously moved through the working chamber by means of a winding mechanism.

Raw material 4 is fed from container 1 onto a transport belt that transmits microwave radiation and enters the installation where processing takes place. As it passes through the chamber, the processed substance becomes 50-80% lighter by removing all liquid from the processed product. The moisture evaporated from the raw material is removed using an exhaust fan and ventilation pipes 6. After passing through the drying cycle through the microwave chambers, the raw material enters the receiving system from the conveyor belt 5.

To protect personnel working with this installation from microwave radiation, protective screens 2 are provided, which are installed at the inputs and outputs of microwave cameras. Protective screens are flexible foil sheets on which a material absorbing microwave radiation is applied. This solution allows you to absorb the excess microwave energy reflected from the raw material.

The process of starting the installation takes place in the following mode: before turning on the magnetron generators, the conveyor belt is set in motion, then the power sources of the magnetrons and the engine of the ventilation system are turned on. Then the processed material begins to arrive on the conveyor belt from the delivery system. By this moment, the magnetrons are already entering the operating mode, and the technological process of drying the processed material is taking place. You can start the unit both from the remote control 8, which is located in the immediate vicinity of the unit, and remotely.

Research results. The power supply circuit of the microwave installation is shown in figure 2. The frequency converters ПЧ1, ПЧ2 are connected to the phases of the network through the ЭМС filter to control the electric motors M1, M2 of the conveyor drives and the ventilation system, as well as the rectifier B, which forms a DC link, from which magnetron generators MG1...MG6 receive power.

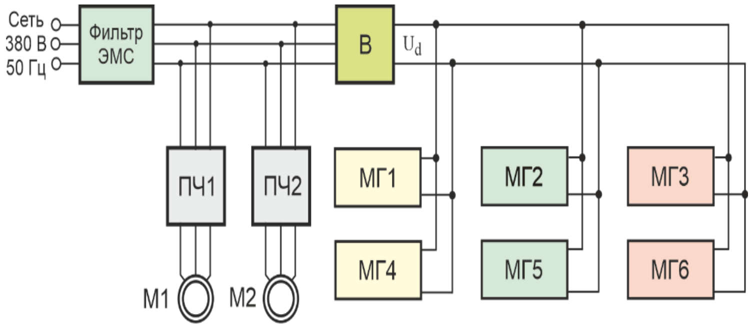

Figure 2 – Scheme of the power supply of the microwave installation

Magnetron generators are made according to the circuit (fig. 3) containing an inverter И, which is connected to the DC link through a pulse voltage converter ИПН and a smoothing filter СФ. The inverter generates an increased frequency voltage (about 20 kHz), due to which the TA transformer has a significantly smaller weight and dimensions than a transformer operating at a frequency of 50 Hz.

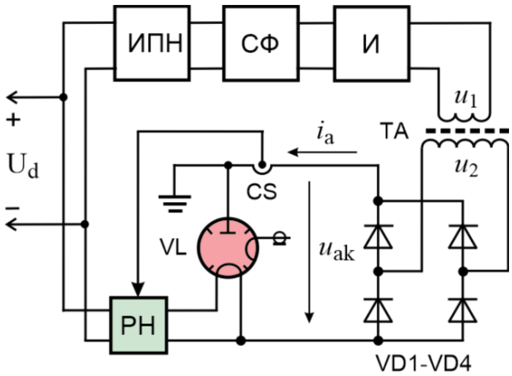

Figure 3 – Scheme of the magnetron generator

The voltage on the secondary winding of the transformer TA is rectified by a high-voltage diode bridge VD1...VD4 and is fed to the anode-cathode gap of the magnetron VL. The pulse voltage converter makes it possible to maintain a given power level of the microwave generator during mains voltage fluctuations and corresponding changes in the DC link voltage. The cathode is heated by a voltage regulator RN, which provides the necessary path of the heating current in the process of heating the cathode and the output of the magnetron VL to the operating mode. To control the power of the microwave installation at a certain point on the conveyor belt, the power of one of the six magnetrons is changed. This is realized by controlling the PSI and the corresponding voltage change at the magnetron anode relative to the cathode. If the power of the magnetrons is not enough, or some of them are out of order, it is possible to adjust the power in another way.

Heating sensors installed at the outlet of each chamber and giving temperature readings on the surface of the processed material transmit readings to the control panel of the installation. Further, the operator makes changes to the speed of rotation of the conveyor belt drive, thus adjusting the processing time of the raw material with microwave energy during its passage through the chambers.

The studies carried out in [9] showed that the power supply circuit with a thyristor controller does not ensure stable operation of the microwave installation even when an alternating current generator is used as an energy source, the shaft of which is driven by a diesel engine. In the case of using a wind generator, the frequency and effective value of the supply voltage of the magnetron generator will be determined by the wind load.

There are different options for circuit solutions that allow you to power the magnetron circuits from a wind generator through an intermediate DC link, in which the energy flows of a generator with a variable shaft rotation speed and an energy storage device are summarized. Solar panels generate direct current electrical energy, while the voltage depends on solar insolation, panel temperature and load [10-20].

It should be noted that the use of only one type of RES may be economically unprofitable in areas with large differences in wind speeds or the arrival of solar radiation. Based on this, it is more expedient to use the combined use of renewable energy sources of various types of electrical energy.

Conclusion. The magnetron power supply in this installation contains an intermediate link of increased frequency, implemented using IGBT transistors. This solution makes it possible to get rid of numerous disadvantages inherent in systems with voltage conversion at a standard frequency of 50 Hz: large dimensions and weight, high cost, low efficiency, and low accuracy of magnetron output power control. Thus, the proposed design of a conveyor-type microwave installation with a magnetron power supply with an increased frequency link makes it possible to dry bulk materials with full control of the output power of the magnetrons, as well as reduce the cost of the installation and improve the weight and size parameters of the magnetron power supplies.

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ТҮЙІН

Қазіргі уақытта Қазақстан Республикасында орталықтандырылған желілерге қосылмаған аумақтардың саны көп. Мұндай аумақтардағы объектілерді электрмен жабдықтау күрделі міндет болып табылады, оны шешу айтарлықтай материалдық шығындарды талап етеді. Микротолқынды технологияларды қолдану ауылшаруашылық өнімдерін өңдеудің перспективалық бағыты болып табылады. Орталықтандырылған электрмен жабдықтау желілерінен айтарлықтай қашықтықта орналасқан шаруашылықтарды дамыту жағдайында автономды электрмен жабдықтауы бар микротолқынды қондырғыларды дамыту және құру кезек күттірмейтін міндет болып табылады. Орталықтандырылған электрмен жабдықтау желілерінен айтарлықтай қашықтықта орналасқан шаруашылықтарды дамыту жағдайында жаңартылатын энергия көздерін пайдалану ең тиімді шешім болып табылады. Мақалада сусымалы материалдарды кептіруге арналған микротолқынды қондырғының конструктивтік ерекшеліктері қарастырылады, онда қажетті технологиялық режим магнетрондық микротолқынды генераторлардың қуатын және өңделген өнімнің қозғалыс жылдамдығын бақылау арқылы қамтамасыз етіледі.

РЕЗЮМЕ

В настоящее время в Республике Казахстан имеется большое количество территорий, не подключенных к централизованным сетям. Электроснабжение объектов на таких территориях представляет собой сложную задачу, решение которой требует значительных материальных затрат. Применение СВЧ-технологий является перспективным направлением при обработке сельскохозяйственной продукции. В условиях развития фермерских хозяйств, находящихся

на значительном удалении от централизованных сетей электроснабжения, разработка и создание СВЧ-установок с автономным электроснабжением является актуальной задачей. В условиях развития фермерских хозяйств, находящихся на значительном удалении от централизованных сетей электроснабжения, применение ВИЭ является наиболее эффективным решением. В статье рассмотрены конструктивные особенности СВЧ-установки для сушки сыпучих материалов, в которой требуемый технологический режим обеспечивается за счет регулирования мощности магнетронных СВЧ-генераторов и скорости перемещения обрабатываемой продукции.

ӘОЖ 004.048
ҒТАХР 20.53.19 *DOI 10.56339/2305-9397-2022-3-3-231-242*

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DATA MINING ТЕХНОЛОГИЯСЫН ҚОЛДАНУ АРҚЫЛЫ БІЛІМ АЛУШЫЛАРДЫҢ ОҚУ ҮЛГЕРІМІН ТАЛДАУ
ANALYSIS OF STUDENTS' ACADEMIC PERFORMANCE USING DATA MINING TECHNOLOGY

Аннотация

Мақалада деректерді іздеу технологиясы, машиналық оқыту әдістері және кластерлік талдау негізінде есептерді сәйкестендіру, реттеу жүргізілді, университетіміздің білім алушылардың үлгерімі талдалып, алгоритмдері сипатталады.

Data Mining технологиясының көмегімен ақпараттық жүйелер және технологиялар білім беру бағдарламасының білм алушыларының үлгеріміне талдау жасалды. Data Mining