## ТЕХНОЛОГИЯ ПРОДОВОЛЬСТВЕННЫХ ПРОДУКТОВ

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# ИННОВАЦИОННЫЕ РЕШЕНИЯ ДЛЯ СОВЕРШЕНСТВОВАНИЯ КОНСТРУКЦИИ РАСПЫЛИТЕЛЬНОЙ СУШИЛЬНОЙ УСТАНОВКИ

# THE INNOVATIVE SOLUTIONS FOR IMPROVING THE DESIGN OF SPRAY DRYING PLANTS

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***Аннотация.*** *Статья посвящена исследованиям по разработке рациональной конструкции распылительной сушильной установки. Предложенная конструкция позволяет увеличить интенсивность процесса сушки при производстве сухих дисперсных материалов в пищевой и химической отраслях промышленности.*

***Материалы и методы.*** *В статье приведены принципиальная схема и описан принцип действия разработанной установки распылительной сушки.*

***Результаты, обсуждения, вывод.*** *Результаты исследований и конструкторские решения позволяют усовершенствовать установки распылительной сушки и использовать распылительную технологию сушки для получения сухих дисперсных материалов высокого качества.*

**Ключевые слова:** сушка, распылительная сушка, сушильная установка.

***Abstract.*** *The article is devoted to research on the development of a rational design of the spray dryer. The proposed design allows to increase the intensity of the drying process in the production of dry dispersed materials in the food and chemical industries.*

*The article presents a schematic diagram and describes the principle of operation of the developed spray drying unit.*

***The results*** *of research and design solutions allow to improve the installation of spray drying and use spray drying technology to produce dry dispersed materials of high quality.*

**Key words:** drying, spray drying, drying installation.

**Introduction.** Traditionally, for the implementation of the drying process in the production of dispersed materials, convective spray drying installations and dryers with a dense, fluidized, aerial and actually suspended product bed are used. These types of equipment have a high technical level, based on a developed powerful machine-building and scientific and technical base. Spray drying installations are limitedly used for liquid thermolabile materials (extracts, purees, juices, etc.), since they do not provide reliable, efficient and high-quality drying [1, 2, 8, 10].

Of practical interest are the results of research and development work on the development and implementation of rational designs of dryers [3, 4, 11], which make it possible to implement non-stationary aerodynamic modes of phase contact during drying, including with combined methods of energy supply. The use of combined methods with microwave and IR energy supply is promising [5, 6, 12, 13], which allows for higher quality indicators of dried products, but inevitably leads to an increase in production costs. In addition, research on the development of practical recommendations for the modernization of existing drying plants to increase their productivity and thermal efficiency is relevant.

**Characteristics of the research object.** Based on the analysis of scientific, technical and patent literature, it was concluded that a promising direction is the development of a design solution for organizing the process of spray drying of liquid and pasty materials, which allows you to create a stable directional spiral aerodynamic contact with a large number of turns between the product and the drying agent in the working chamber.

The object of research is the structural elements of spray drying plants.

**Research results and their discussion.** A promising design solution for dewatering liquid and pasty materials is a spray drying installation (Figure 1), developed by a group of authors under the leadership of Professor I.Yu. Aleksanyan [14].

As a result of continued research, the design was improved and a patent for a utility model was obtained [15], which additionally confirms its industrial applicability. There is no conflict of interest. The authors have proven that the intensification of the heat and mass transfer process in this design when the particles of the dried material interact with the drying agent is achieved by replacing vertical rectangular partitions with vertical curved partitions (Figure 2).

The proposed device (Figures 1 and 2) has a cylindrical drying chamber 1, made in the form of two series-connected cylinders, small 2 and large 3, of different diameters, a sprayer 4 installed along the axis of the chamber 1, a suction system 5 installed under a large cylinder 3 and unloading unit 6 in the form of a hollow cone installed under the large cylinder 3 along the axis of the chamber 1.

Small cylinder 2 has a drying agent 7 inlet. Large cylinder 3 has a drying agent 8 inlet located tangentially to the surface of a large cylinder 3.

In the cavity of a large cylinder 3, vertical curved partitions 9 are installed and rigidly fixed in a circular array around the axis of the drying chamber 1 with gaps between themselves, forming curvilinear slot channels and between partitions is $\alpha = 360/n$, where n – the number of partitions (Figure 2). The partitions 9 are rigidly fixed on the inner surface of the large cylinder 3 with the help of fasteners 10 and rod fasteners 11 to stiffen the structure (Figure 2), and the large cylinder 3 and vertical curved partitions 9 are made the same in height.

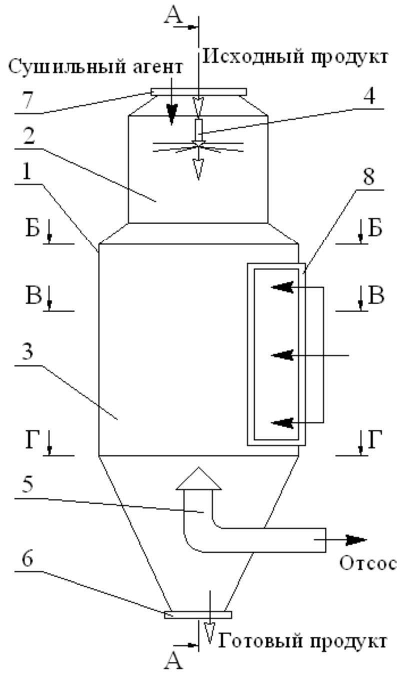


Fig. 1. Spray dryer
1 - drying chamber; 2, 3 - cylinders; 4 - sprayer; 5 - suction system; 6 - unloading unit; 7, 8 - branch pipes;
9 - vertical rectangular partitions; 10 - fasteners; 11 – fasteners

The initial product to be dried is fed by a spray gun 4 into the volume of a small cylinder 2. The drying agent is injected through the nozzles 7 and 8. The sprayed particles of the product, upon contact with the drying agent, dry up and are taken through the unloading unit 6, the spent drying agent is removed through the suction system 5.

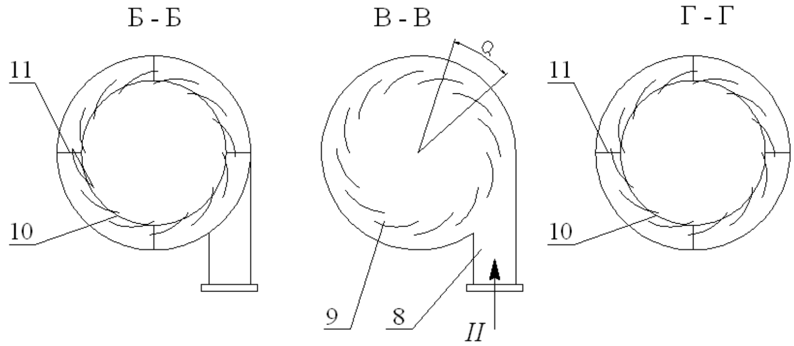


Fig. 2. Spray dryer (sections)
8 - branch pipe; 9 - vertical curved partitions; 10 - fasteners; 11 - fasteners

Due to the introduction of the drying agent through the branch pipe in the large cylinder tangentially to the circumference of the large cylinder and the presence of vertical curvilinear partitions in it, an additional uniform supply of the drying agent is carried out into the curved slotted channels between the partitions, while the sprayed product particles, entrained by the coolant flows, begin to rotate about the axis drying chambers and make a directed motion along a downward spiral trajectory.

Thus, an increase in the number of turns of the active spiral aerodynamic contact of the product and the drying agent in the drying chamber is achieved, which makes it possible to increase the residence time of the sprayed particles of the product in the drying chamber and provides an intensive flow of the drying agent around the particles and increases the intensity of the drying process. The spiral trajectory of the particles movement determines the longer contact time of the product with the drying agent in the chamber compared to the traditional straight-line downward movement, which makes it possible either to reduce the height of the drying chamber at a given productivity, or to increase the process intensity and plant productivity.

The ratio of the consumption of the drying agent supplied through the nozzles and the number of baffles depend on a number of factors: the productivity of the installation, the parameters of the spray pattern, the drying time, the geometric characteristics of the drying chamber, etc.

The positive effect of the proposed device is provided by improving the design of the dryer.

Further development is being carried out by conducting research on taking into account the kinetic laws and a set of properties of drying objects, including thermodynamic, structural-mechanical and thermophysical properties, when designing drying equipment. In addition, it is necessary to develop mathematical models [4] for operational control of the process and product quality, as well as automation of the drying plant [7, 12].

**Conclusions.** The results of the analysis confirm that an urgent direction is the development of methods for intensive drying of raw materials in a dispersed state, as well as design solutions to minimize or eliminate the disadvantages inherent in traditional drying plants. Further development is received by spray drying with active vortex aerodynamic contact of the product and the drying agent. The developed recommendations allow using the spray drying technology to obtain high quality dry dispersed materials. A utility model patent was obtained for the design of the facility [15], which confirms the competitiveness and industrial applicability of the development.

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