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ПРИМЕНЕНИЕ ВИБРАЦИЙ В ПРОЦЕССЕ ИЗВЛЕЧЕНИЯ ИЗ СЫРЬЯ РАСТИТЕЛЬНОГО ПРОИСХОЖДЕНИЯ

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РЕЗЮМЕ: Проведен анализ характеристик современных конструкций вибрационных экстракторов в сравнении с общепринятыми технологиями. Рассмотрено влияние вибрации на процесс экстракции. Исследована возможность использования вибрационного аппарата в процессе экстракции в твердофазной системе для повышения эффективности экстракции растительного сырья.

КЛЮЧЕВЫЕ СЛОВА: традиционные методы экстракции; экстракторы с применением вибрации; вибрационные насадки.

APPLICATION OF VIBRATIONS IN THE PROCESS OF EXTRACTION FROM RAW MATERIALS OF VEGETABLE ORIGIN

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ABSTRACT: Analysis performed of the characteristics of modern designs of vibration extractors in comparison with common technologies. The influence of vibrations on the extraction process is considered. The possibility of using vibrating apparatus in the extraction process in a solid-phase system to increase the efficiency of the extraction of plant raw materials is considered.

KEY WORDS: traditional extraction methods; vibration extractors; vibrating attachments.

INTRODUCTION

The source of biologically active substances widely used in the manufacture of products in the pharmaceutical industry is plant raw materials [1]. The main task facing scientists, chemists and technologists involved in the development of innovative technologies and modernization of

traditional processes and devices is to increase the efficiency of extraction of target components. Extraction in the liquid-solid system is one of the most common methods for extracting biologically active substances.

Traditional extractor designs contribute to stability in operation. They are easy to operate. Based on solid-liquid technology, the extraction time and the amount of product in relation to the solid matrix can be predicted. On the other hand, they have many disadvantages. They consume a large amount of expensive and pure solvents, have low extraction selectivity, have a high rate of solvent evaporation during the extraction process, and, as a rule, are characterized by a long extraction time and thermal decomposition of thermolabile compounds [8]. To overcome these disadvantages, traditional methods are constantly being modified. One of the ways to intensify production is the introduction of structures that use the effect of vibration. In this regard, we were assigned the following tasks. Study the mechanisms of the extraction processes. To give a generalized assessment of modern designs of vibration extractors in the patent literature over the past ten years. Compare traditional solid liquid extraction methods with innovative ones using vibratory technique.

MATERIAL AND METHODS

A review of the patent literature of modern designs of vibration extractors was carried out.

RESULTS

Traditionally, the extraction is carried out using extracting organic or inorganic liquids and their mixtures in contact with an insoluble solid matrix (for example, the Soxhlet method), as well as using methods of sequential increase in atmospheric pressure, such as maceration or percolation, or a simple squeezing method [15, 16]. Solid liquid extraction is based on a simple phenomenon. If a solid matrix containing extractable compounds is immersed in a liquid, the latter begins to be enriched in certain chemically bound substances, which move from the inside to the surface of the solid, and then from the surface into the liquid. This principle is based on diffusion and osmosis and is carried out by maceration, which is the simplest and most economical extraction method and is therefore widely and effectively used. The maceration process requires only a closable glass or steel container in which the solid to be extracted is covered with liquid. To overcome the rapid saturation of a liquid strictly around a solid, random mixing is required [6]. Unfortunately, maceration is not always applicable as long contact times are required between the solid and the liquid. For example, plants cannot macerate for a very long time in water at room temperature due to the phenomena of decay. The production needs of the industry, requiring the production of large volumes of extracts in a short time, have found application in percolation extraction [2, 5]. In this case, it is possible to process significant amounts of solid material with large volumes of liquid and obtain the extract quite quickly, although at the expense of extraction efficiency, which remains low due to the limited contact between the solid and the extracting liquid. In this case, the solid matrix is not completely depleted and the substance can be recovered using another technique.

It is possible to reduce the time and intensify the mass transfer processes due to the vibration effect [17]. When a vibration field of low-frequency mechanical vibrations is imposed on the interacting phases, active hydrodynamics is enhanced. The main provisions of the scientific hypothesis of the use of vibration are the following statements. An increase in the driving force of the dissolution process and a decrease in the cohesive forces of interaction of dispersed particles with the blade. An increase in the number of equilibrium conditions of dispersed particles in a liquid dispersion medium subject to a decrease in resistance in a liquid technological mass during stirring, an increase in the rotation speed of the blade shaft and a decrease in energy consumption during the operation of the mixer. Improving the quality of mixing due to the free bottom of the working area from sediments and self-cleaning of working bodies from sediments.

Low-frequency vibrations cause high efficiency of mass transfer with high efficient performance [7]. Vibration extractors are classified into horizontal and vertical. Heat and mass transfer processes can take place in them, both in continuous and in periodic mode. Vibration promotes grinding of raw materials, as well as the occurrence of convection, turbulation and pulsation of the extractant [3].

A useful model of a vibration extractor is known, in which the technical result is achieved by a one-time injection of an extractant and a solid phase, which leads to an increase in the contact time of the phases; the presence of a heating jacket, which heats the mixture of liquid and solid phases; perforated screw turns for even distribution of the extractant and better heat transfer

conditions. All of the above causes a higher productivity of the apparatus and an increase in the efficiency of extraction [10].

In order to provide a more intensive washing of solid particles by the extractant and to increase the contact time of the phases, a design of a vibrating extractor of periodic action was proposed. The desired effect is achieved by the arrangement of rigidly fixed partitions in the apparatus with overflow slots arranged in such a way that partitions with slots alternate in the center and on the periphery. In the sections formed by the partitions, trays with conical or cylindrical perforations are installed, which are necessary for better crushing of the solid phase and increasing the intensity of mass transfer. The openings from tray to tray increase, reaching their maximum size in the lower sections of the apparatus [11].

In order to create a mode close to ideal mixing in the apparatus, vibrating nozzles are used in industry [9]. Known nozzle for vibration mass transfer apparatus, the positive effect of the use of which is to expand the range of stable operation, increase the productivity and efficiency of the processes carried out in the vibration apparatus [12]. The advantages of using such packings are specific capital investments, simplicity of design, and low metal consumption [14].

These nozzles are widely used in extractor designs. One of the latest developments with the use of this device is an extractor with a vibrating attachment. It has reduced the element base of the external recirculation loop and improved the operational characteristics of the installation [4] in comparison with the vibration extractor, which is the closest in technical solution [13, 18], which has a large number of additional devices for cleaning and returning the extractant to the apparatus body, which significantly increases capital and operational costs, installation dimensions of the device and the complexity of maintenance.

CONCLUSION

As a result of the research carried out, the following conclusions can be drawn. Among the various forms of mechanical action in the extraction processes, vibration action is one of the most effective methods. Adding a vibration field to the technological environment significantly activates and intensifies the processes of heat and mass transfer, improves the quality of mixing materials with different physical and mechanical properties, and helps to reduce the duration of technological operations and energy consumption. The vibratory effects of mixing ensure uniform and intense mass transfer between solid and liquid phases and have great potential for energy-saving technologies. Vibratory extractors, in comparison with traditional ones, have a higher specific productivity, provide a reduction in mixing time, metal consumption, energy consumption and capital costs. Vibrations in the process of extracting plant raw materials make it possible to increase the completeness of the extraction of biologically active substances.

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