Section 2. EQUIPMENT OF FOOD PRODUCTION ENTERPRISES AND IMPROVEMENT OF PROCESSES AND APPARATUSES OF FOOD PRODUCTION ENTERPRISES

DEVELOPMENT OF ENERGY EFFICIENT EQUIPMENT FOR DRYING HYDROBINOTS (NON-FISH PRODUCTS OF THE SEA)

G. Deynichenko, V. Guzenko, O. Melnik, V. Perekrest

The article is devoted to the development of technical equipment for the drying process of thermolabile hydrobionts (non-fish products of the sea). Modern methods of drying hydrobionts with the use of warm air are described and their main drawbacks are found concerning their main drawbacks regarding the drying of thermolabile hydrobionts (non-fish products of the sea). The urgency of the development of new energy-efficient equipment designs, in particular, for drying process of thermolabile hydrobionts (non-fish products of the sea) in the fluidized layer is given. It will allow to determine optimal parameters of the process, the correct choice of which will improve the quality of the initial products, increase energy saving and intensity of the drying process. The results of the patent search for the existing drying equipment for drying the hydrobionts (non-fish products of the sea) are presented, and their shortcomings are described. The ways for the improvement of the methods and equipment are proposed to develop resource-saving technology for drying thermolabile hydrobionts (non-fish products of the sea). A new industrial equipment (drying plants) is developed to carry out the drying process for various types of thermolabile hydrobionts (non-fish products of the sea) in a fluidized bed using oscillation and a vibro-boiling layer. The article describes the design of the proposed drying plants for the intensification of thermolabile hydrobionts (non-fish products of the sea) drying. The advantages of the proposed equipment for the intensification of thermolabile hydrobionts (non-fish products of the sea) drying are determined. The developed new constructions of drying equipment, in particular, for drying the thermolabile hydrobionts (non-fish products of the sea) makes it possible to reduce metal and energy consumption, intensify the mixing of the product, obtain a large amount of the product of specified humidity, mass exchange, reduce the pelletization of the product.

Keywords: hydrobionts, thermal lability, process, drying, equipment, fluidization, vibro-boiling, layer
DEVELOPMENT OF UNIVERSAL IR-DRYER OF ORGANIC NATURAL RAW MATERIAL

L. Kiptela, A. Zahorulko, A. Zagorulko, B. Liashenko

Today the demand of the population of Ukraine and other European countries for quality organic food products is growing. First of all, it is the demand for organic natural semi-finished products which contain a significant amount of biologically active agents, smell and look good, and are also reasonably priced. In most cases drying is used to process this raw material. Drying of organic natural raw materials is a complex technological and structural task for modern engineering.

To solve this problem, many enterprises carry out technical upgrades by equipping them with modern economic, reliable equipment, which allows minimizing the raw material losses during technological operations. But increasingly there is a need for the development of conceptually new resource- and energy-saving equipment using modern low-metal infrared emitters and energy-saving devices.

The purpose of this article is to increase the resource and energy efficiency of the organic natural raw material drying process by developing a conceptually new multi-purpose infrared continuous dryer with a rational shape of the process chamber intended for simultaneous drying of up to four types of raw materials.

During the design process, the following tasks were assigned, i.e. improvement of the heat transfer efficiency; reducing the duration of the drying process due to ensuring the uniformity of the temperature field on the receivers and in the process chamber of the device as a whole and using the vibration; effective constructive placement of the energy-saving device and improvement the quality of the output products.

Multi-purpose infrared dryer for organic natural raw materials is intended for drying of up to four types of organic natural raw materials due to continuous operation. In the device a flexible film electrical resistance heater of radiant type is used as a heater, which is installed on the inner surface of the dryer and the outer surface of the inner overhead pipeline located in the center of the device’s operating space.

The high quality of dried semi-finished products is achieved by reducing the duration of heat treatment of raw materials with the application of mild temperature conditions (40–60°C) and vibration.

Keywords: development, multi-purpose infrared dryer, organics, flexible film electrical resistance heater of radiant type (GPRENVT), vibration, energy saving.
CONSTRUCTIVE FEATURES OF TRANSCRITICAL BOOSTER REFRIGERATION SYSTEMS

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Natural refrigerants are becoming increasingly important (air, water, hydrocarbons, carbon dioxide and ammonia) in connection with the measures which are taken by the international community for reducing of production and consumption of ozone destruction substances and greenhouse gases.

Dioxide of carbon (carbon dioxide, CO₂, R744) is one of the most promising natural refrigerants, which can be used as working substance in various refrigeration systems.

Distinctive feature of refrigeration systems which operate on the base of transcritical cycle with use of CO₂ is the state of overcritical fluid in which refrigerant is on the high pressure side, it causes high values of the heat transfer coefficient and low values of viscosity. Transcritical refrigeration systems with use of CO₂ became widespread in refrigeration systems of retails. Compared with traditional plants with use of chlorofluorocarbons (CFC) refrigerants, the use of the transcritical system under moderate climate allows reducing annual energy consumption by 15–20%. To date, transcritical booster refrigeration systems become the most widespread. The booster system is a system where two stages of compression of one refrigerant exist. The computational pressure in the high pressure section, as a rule, is from 90 to 120 bars, working pressure is from 45 to 100 bars.

The main difference of the transcritical booster refrigeration system is the heat exchanger; it is gas cooler which is intended for cooling of the compressed to high pressure refrigerant.

The construction of the gas cooler compared to the existing traditional condensers is much more complex, including increased working pressure (up to 150 bars), which is almost in 4 times higher, and in 2 times higher temperature (+150°C) and it has a number of features.

One more significant constructive difference is the necessity to maintain intermediate pressure in the receiver of the transcritical refrigeration system in case of idle time.

Increasing of the maximum working value of pressure for system’s components should be taken into account. For the system with use of CO₂, the pressure under idle time can reach values of 65–80 bars (which corresponds to the temperature of 25–30°C). It exceeds the maximum working pressure of most components of the system and requires additional measures for pressure reducing and maintaining.

The auxiliary cooling system of the receiver and partial release of CO₂ into the atmosphere are the most commonly used measures for pressure maintaining under the transcritical refrigeration plant stoppage.

The vaporizers of transcritical refrigeration plants are not exposed to particularly high pressures. Usually the maximum working pressure is within 45–60 bars. Such pressure does not require special construction of evaporator, but only
some adjustments to the thickness and diameter of the pipes. The sizes of the pipelines of plants can be significantly reduced due to the efficiency of \( \text{CO}_2 \). Usually the diameter is from 3/8 ”to 5/8”, and it is possible to use evaporators of smaller sizes for necessary productivity providing.

It is necessary to note one more important constructive feature it is the possibility of efficiently use of recuperation for receiving hot water for technological needs and heat-transfer agent heating in transcritical systems with use of \( \text{CO}_2 \). All heat is highly potent, that is why actually all overheating can be used by shutdown of gas cooler if it is necessary.

**Keywords:** \( \text{CO}_2 \), transcritical phase, booster system, working pressure, gas cooler, receiver, pipelines, carbonic acid.

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**CREATION OF RESOURCE-SAVING EQUIPMENT FOR THE EXTRACTION OF PLANT RAW MATERIALS**

G. Deynichenko, V. Guzenko, Z. Mazniak, O. Udovenko, O. Omelchenko

The article is devoted to a new approach to the issue of technical equipment for extracting valuable substances from plant raw materials and developing resource-saving equipment for its implementation. The role of equipment in the extraction of plant raw materials, as well as the types of constructions for modern extraction of plants for obtaining valuable substances from plant raw materials and the matters of their further improvement are described. The necessity of creating new industrial resource-saving extraction equipment with the purpose of increasing efficiency of obtaining valuable substances from vegetable raw materials is determined. The results of a patent search of the existing extraction equipment for the extraction of plant raw materials are presented and their essential shortcomings are described. A new design of an industrial plant for obtaining extracts from various types of plant raw materials and their further use was developed. The device of the developed plant for the extraction of plant raw materials and its operating principles are described. The developed plant can be used in the food, pharmaceutical and microbiological industries during the production of various valuable substances (starch, fiber, pectic substances and other dietary fibers), lipids, vitamins and other valuable substances in plant raw materials that require the transfer of a soluble substance to a solvent. The advantages of the proposed device for obtaining plant extracts are to facilitate its maintenance and ensure the continuity of operation, simplify the replacement of the stirring element, intensify the process of extracting valuable substances from various types of plant raw materials and reduce the working cycle, and reduce the resource costs.

**Keywords:** plant raw material, process, extraction, equipment, mixing, resource saving.
MASS EXCHANGE MODULE FOR THE IMPLEMENTATION OF THE PROCESS OF VEGETABLE RAW MATERIAL DRYING

V. Potapov, E. Yakushenko, E. Stoyan

The problem of production food products which are enriched with various biological active additives is extremely topical for Ukraine in the conditions of the economic and ecological crisis. It leads to increasing of the population morbidity, the reason of which in a large measure is the existence of dietary rations deformation.

The production of powders which are obtained by various drying methods allows realizing waste-free processes of agricultural products processing and it is one of the perspective ways of agricultural raw materials rational use.

The study which is carried out by the authors, shows the promising use in the process of vegetable raw material drying of the two-level functional container (FC), as the base for the mass exchange module (MEM) creation. But the functional container of such construction has principle drawbacks such as technological drawbacks from the production point of view (the restriction of functional container large sizes) and practical drawbacks (impossibility to mechanize the process of loading and unloading of functional container, and it does not allow the drying process automating).

The proposed constructive and technological solutions for the development of MEM use the ideology of the two-level functional container and allow elimination of the above-mentioned drawbacks.

The obtained results allow construction of the basic drying module which implements the drying process and has operational productivity not less than 300 kg per hour.

Keywords: drying, vegetable raw material, mass exchange module, functional container, hydrophobic coating, silicon organic lacquer.

IMPROVEMENT OF THE METHOD OF OBTAINING WATER-FAT EMULSIONS FOR LUBRICATING BAKING MOLDS

G. Postnov, V. Chervonyi, V. Chelombitko, O. Postnova

A method for producing water-fat emulsions for lubricating baking forms is proposed. The results of experimental studies on the use of ultrasonic treatment for efficiently carrying out the emulsification of vegetable oil are presented, and a study is made of the effect of ultrasonic treatment on the efficiency of the process.

The process of obtaining water-fat emulsions using unrefined vegetable oil in the field of ultrasonic waves at a frequency of 22 kHz occurs within 10–15 min with an emission intensity of 3–5 W/cm².

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Due to the use of ultrasonic treatment, the dispersion of the emulsion is increased. Reducing the cost of cooking is due to the fact that obtaining a stable emulsion is possible with the use of a minimum amount of valuable phosphatides or without them at all.

The resulting emulsion does not require special storage conditions, and can be used directly after cooking or later.

An improvement in the process of obtaining water-fat emulsions with the help of ultrasound is proposed, which allows to obtain a high-quality product, which is recommended for lubricating baking forms, which will help reduce the formation of carbon deposits, simplify the extraction of bread, and allow the production of high-quality bread products. Also, fine emulsions can be used as ingredients for additives in flour products.

Further research will be aimed at determining the yield of baked bread.

The results of the research will contribute to the formulation of the main technological, operational and environmental requirements for efficiently carrying out the emulsification process of vegetable oil, as well as offering a schematic diagram of the hardware design of the relevant process.

Keywords: ultrasound, emulsion, vegetable oil, lubrication, baking forms, frequency, size, disperse phase.

STUDY OF HEATING IN THE PROCESSES OF MANUFACTURING SEPARATE CONCENTRATES FROM PLANT RAW MATERIAL

O. Mayak, A. Sardarov, G. Shershnev

The article discusses new energy-saving low-waste methods of producting concentrated products based on fruit and vegetable raw materials: candied fruits, pasty beverage concentrates, dry confitures and separate concentrates. The proposed method of concentrated products manufacture involves the following core processes: milling fruit and vegetable raw materials, boiling down under vacuum and vacuum drying. Boiling of the puree under vacuum in the conditions of constant mixing of the concentrate is assumed for the production of paste-like beverage concentrates and confitures. For the manufacture of candied fruit and separate concentrates vacuum drying of raw materials with subsequent grinding is to be used.

The dependence of the heat transfer coefficient on the number of turns of the mixer, in the production of separate concentrates from vegetable raw materials is determined. The efficiency of using a device with a simple and reliable construction for mixing and heating viscous food products is proved. Also it helps to reduce the length of the product processing process and improve the quality of the finished product due to better mixing and intensification of the heat transfer process by using
spiral metal tubular designs for the supply of coolant, which contributes to the increase of the contact area of the product with heating elements.

The scrapers are located on the helix in such a way that they block each other while driving. When rotating the mixer, the scrapers move near the surface of heat exchange wall of the apparatus, forming a screw surface, which facilitates the turbulization of the wall laminar layer of the product, it prevents it from sticking, eliminates stagnant zones, resulting in temperature equalization and uniform flow of the process.

**Keywords:** concentrated products, vegetable raw materials, mixing device, heat transfer.

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**IMPROVEMENT OF THE COMBINED PROCESS OF JERUSALEM ARTICHOKE CLEANING**

N. Afukova, D. Dmytrevskyi, D. Horielkov, R. Bondarenko

Development and improvement of the process of vegetable raw materials cleaning is an actual scientific and technical goal. One of the most perspective directions of intensification of vegetable cleaning process is the development of the combined methods for their processing. The improvement of the tuber cleaning process is based on the combination of the process of heat treatment of Jerusalem artichoke with steam and the process of subsequent mechanical after-treatment.

The necessity of creating equipment for the realization of the combined cleaning process of Jerusalem artichoke tubers is proved. A combined purification process, which is based on the combination of thermal and mechanical effects on the product under purification is proposed.

Experimental studies are carried out to study the influence of the parameters of the process of Jerusalem artichoke heat treatment on the change on the surface layer of the tuber. The influence of steam pressure and the duration of tubers’ heat treatment on the depth of thermal treatment of the tuber surface layer, as well as on the efficiency of peel separation, is investigated. In addition, the influence of the duration process of tubers’ mechanical after-treatment on the quality of cleaning is studied.

An experimental sample and an appropriate technique that allow to carry out investigations of the combined process for cleaning Jerusalem artichoke tubers with the ability to determine the influence of all its parameters on the percentage of raw material losses and the quality of cleaning are developed. Rational parameters of the combined process of Jerusalem artichoke cleaning are established.

It is proved that the increase of steam pressure and duration of heat treatment process raise the depth of thermal treatment of the surface layer and reduce separation forces of peel from the tuber. It is determined that an increase in
the duration of mechanical after-treatment process increases the percentage of peeled tubers of Jerusalem artichoke, but increases raw material losses. It is determined that the reduction in the separation force of Jerusalem artichoke peel during heat treatment makes it possible to reduce the duration of mechanical post-treatment process. It is determined that with increasing depth of thermal treatment of the surface layer of Jerusalem artichoke, raw material losses grow. It is proved that Jerusalem artichoke tubers, which have a longer shelf life, need to increase the duration of their mechanical post-treatment process to ensure the required quality of cleaning.

Rational parameters of the combined process of cleaning Jerusalem artichoke are determined, which allow significantly intensifying and mechanizing the cleaning process, decreasing raw material losses and improving the quality of cleaning.

**Keywords:** Jerusalem artichoke, combined effect on raw materials, cleaning parameters, preliminary heat treatment, mechanical after-treatment.

**ACCELERATION OF EMULSION AS A BASIC FACTOR OF HYDRODYNAMIC DISPERGATING OF MILK FAT PHASE**

K. Samoichuk

The article highlights the main obstacle to the creation of highly effective homogenizers of fat emulsions with the reduced energy consumption – the lack of a uniform theory of fine dispersed emulsions dispersion and, as a consequence, a single factor (factors) for the destruction of fat particles (droplets) of the dispersed phase. The reasons for using the universal criterion of a fatty ball deformation and destruction are shown – Weber's criterion, for determining which it is necessary to calculate the slip rate of the disperse particle in relation to the dispersion phase. Given the difficulty in determining the slip rate of fatty particles, it is proposed to use the acceleration parameter of the emulsion. With the advent of acceleration, due to the difference in density between it and the surrounding plasma, inertial forces that cause the fat droplets to move with a speed different from the dispersion medium appear.

The purpose of the article is to determine the relationship between the acceleration of the milk emulsion movement and velocity of the fatty ball relative to its plasma (velocity) and Weber criterion.

In order to achieve the goal, an estimated flow pattern of the emulsion with fatty ball with acceleration is drawn up. As a result of mathematical transformations, based on classical theories of kinematics and hydrodynamics, analytical dependences have been found to determine the mean diameter of the fatty ball after hydrodynamic dispersion and acceleration of the milk emulsion movement based on the criterion for the destruction of Weber drops. The obtained dependences are based on the definition of the acceleration of the emulsion movement – a parameter that is easily determined for any type of homogenizer, which can become universal – a unifying factor for the destruction of fat particles of the emulsions for
most types of homogenizers (valve, jet, pulse, rotary, centrifugal, and membrane).

The index – the homogenization coefficient, which binds acceleration of the emulsion movement with an average diameter of the fat fraction of the milk emulsion, which characterizes physical and mechanical properties of the emulsion, the value of which is to be specified experimentally – is introduced.

A hypothesis that the coefficient of surface tension at the boundary of fat-ball-plasma of milk has physical content of the specific energy per unit of the surface of the fatty ball is put forward. It is similar to the surface theory of the crushing of bodies P. R. Rittinger.

**Keywords:** homogenization, emulsion, milk, homogenizer, dispersion, theory, acceleration of emulsion.

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**CREATION OF THE NEWEST STRUCTURES OF THE INCLINED BUCKET ELEVATORS THROUGH THE MODERNIZATION OF THE EXISTING ONES**

V. Mykhailov, A. Shevchenko, S. Udovikova, N. Gaydar

New designs of buckets with the inclined bucket elevators, which have buckets with movable bottoms of different shapes, are developed. High efficiency of such structures’ work is theoretically justified and practically confirmed.

Elevators are used in metallurgy, machine building, chemical production, in concentrating factories and grain storage facilities, in enterprises of various industries, in bases, stores, warehouses, and in particular, in the form of mobile shelf stand for products’ storage and delivery.


The design of buckets with movable elements in the form of bottoms of various shapes, combined with selected parameters of the elevator, proposed in the article, would significantly improve the quality of material unloading, which would help reduce the energy overexpenditure, improve the quality of transported material, and improve working conditions of maintenance personnel. Therefore, this article, devoted to the improvement of productivity of the inclined bucket elevators, is very relevant.

These investigations can also be used for the improvement of the efficiency of any elevator-type loading and unloading machinery.

Thus, movable element of the ladle is the bottom of a certain shape (abbreviated IF or PF) and additional devices to them are small design changes introduced into the elevator design that will allow the following: increase bucket
volume due to depressions in the middle part, which will improve unloading material from the ladle; increase bucket filling ratio; to influence the material from the rotation of its movable bottom, leading the material into motion; increase the unloading path of the recessed part with respect to the additional device; reduce the chance of material sticking in the deepest part of the bucket, without changing the bucket pitch fixed on chains, and thus increase productivity of the elevator plant.

**Keywords:** modernization, elevator, bucket with a semicircular movable bottom (SM), bucket with a curved movable bottom (CM).

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**RHEOLOGICAL PROPERTIES OF THE MAIN TYPES OF MINCED MEAT PROCESSED INTO EMULSIFIER**

K. Myroshnichenko, O. Batrachenko

Further improvement emulsifiers possible when finding new information about work processes in these machines. The actual problem is the reduction of heating of minced meat in its grinding in emulsifier. Previous research has found that the rate of arrival of raw materials from bunkers-feeders emulsifier is not sufficient given the speed of the knife cutter assembly. Consequently, the actual productivity is less than theoretically possible, and heating of the raw material is high due to the fact that per unit mass of raw material accounted for a large emission of heat from the friction of the working bodies. To justify high-performance methods of feeding beef to a cutting site of emulsifier possible only with due account of the rheological properties of raw meat. The methodology of experimental studies of structural-mechanical properties of minced meat was to use a modified electromechanical universal testing machine SANS CMT2503. We used the following nozzle indenture: cylindrical plunger and Magness-Taylor. The raw materials used for stuffing sausage doctoral and minced pork sausages at 8°C. During the tests, the raw materials were installed under the indenter (cylindrical cell filled with the necessary amount of raw material and installed it under the bar, centruose relative to the indenter, and then turn on the drive. The speed of the indenter was $1 \times 10^{-4}$ m/s and $2 \times 10^{-4}$ m/s. As a result of studies have experimentally investigated the structural-mechanical properties of minced meat, which often is processed in emulsifier. The most common module axial compression characteristic of pork sausage doctoral (20,20 kPa) for minced meat sausages pork it takes a smaller value (to 14.04 kPa). The maximum stress standard penetration is also observed for minced meat sausage doctoral (of 7.71 kPa), while for minced meat sausages pork of 7.02 kPa, respectively. The data obtained can be used in the justification of high-performance methods of feeding minced meat to the cutting unit emulsifiers.

**Keywords:** meat comminutor, meat, screw, serve, rheological properties.