

Analysis of promising smoking and pelleting methods and their hardware design

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Abstract

The problem of proper and wholesome nutrition was and remains relevant. At the same time, in connection with the development of progressive technologies for the production of food products, the issue of the compactness and portion size of fast-food products is acute. Scientists are conducting research in this area and are very successful. This article provides an analysis of promising methods for smoking fats, using modern technological equipment, followed by obtaining smoked fats in a solid granular state. The authors studied the operation of experimental installations of different authors. the advantages and disadvantages of patent studies are considered, and on the basis of the analysis, the most promising methods of smoking animal fats are revealed. Based on the analysis of the market for fast food snacks, it should be noted that this kind of snacks are becoming more and more popular.

Keywords

Foodstuffs, smoking, pelletizing, fat tail fat, smoking chamber, extrusion, moisture removal, smoking components, Laval nozzle, heat and mass transfer.

Consumer interest in meat snacks is growing all over the world. Naturally, this predetermines new opportunities for expanding the assortment of snacks on the part of manufacturers. According to the Mintel Group [1], a Chicago-based global market research company, sales of various types of snacks and snacks are on the rise as they grow. consumers are looking for products that satisfy their unassuming, rational and emotional needs, and meat and poultry choices are becoming an increasingly popular part of this range. While traditional snacks,

including potato chips, crackers, nuts, and dried fruit mix, still account for the largest share of sales, meat snack activity is growing rapidly.

Based on the analysis of the market for food products, breakfasts in the form of granules are becoming more and more popular. This category includes smoked animal fats, in particular portioned fat tail fat. It should be noted that fat tail fat occupies an important place in the diet, in the current difficult epidemiological situation. According to medical research, in various sources, it is noted that in case of a disease of the respiratory tract, the alveoli of the lungs, which are covered from the inside with a special substance - surfactant, due to the consumption of animal fats, including fat tail fat, not only keeps them in shape and accelerates the saturation of the blood with oxygen, but and is a kind of barrier for viruses [2].

With regard to the methods of granulation of smoked fat tail fat, these are mixed physicochemical processes that ensure the formation of particles of a certain size, shape, required structure and physical properties of the final product. Such processes are the most common and widely used in food, pharmaceutical, chemical and other industries. The pelleting process is designed to improve the quality of products, including intermediate raw materials. Quality indicators depend on the specifics of the product and its purpose. In general, granulation can significantly reduce the tendency of the product to cake, and, consequently, simplify storage, transportation and dosing. Along with this, granulation opens up the possibility of homogenizing the mixture in terms of physicochemical properties, increasing the surface of heat and mass transfer, regulating the structure of granules and related properties. All this contributes to the intensification of processes in which granular products are used, an increase in labor productivity and production culture.

The goals and methods of granulation, their hardware design, the properties of raw materials and products, the quality requirements of the latter are so diverse that it is not possible to use the results obtained under conditions different from those required without scientific systematization. The study of the essence, mechanism and means of implementing various granulation processes is based on the general laws of physical chemistry, hydrodynamics of dispersed materials and heat and mass transfer in capillary-porous bodies. Nevertheless, at present, there are general principles of approach to the selection of the most expedient granulation methods, depending on the state of aggregation and physical properties of the starting materials.

It is known from the life cycle of mankind that food products were smoked for a long period of time, most often in the air. The development of scientific and technological progress has also affected this area, the most important in human life, the existence of mankind. Studies of scientists from different countries show that to intensify the smoking process by means of

convection gases, and to improve the diffusion process during the granulation of food products, it is advisable to use methods of increasing or decreasing pressure, as well as their alternation. In this regard, an interesting technical solution, which was proposed by scientists from the Voronezh State University of Engineering Technologies, presented in the source [3].

The authors of the invention [3] set themselves the task of developing an installation for smoking granular products with a developed structure. A distinctive feature is that the external supply of smoke allows to increase the rate of directed deposition of smoking components on the inner surfaces of the pores of the product. This factor provides a deeper penetration of smoking components deep into the material and a sequence of processes for the formation of its porous structure. Simultaneously, the evacuation removes steam, non-condensed gas and air. At the same time, smoking is organized continuously in an electrostatic field and the aroma of the product smoke is saturated throughout the volume, which increases the quality of the product as a result of deeper penetration of the smoke components into the pores of the material, which, in addition, makes it possible to increase the storage time of the finished granules.

The technical problem of the invention [3] is as follows: the installation for obtaining smoked products, with external supply of smoke, consists of a smoking chamber connected to a system for generating smoke, i.e. preparation and supply of smoke. The same system creates a vacuum and provides moisture condensation. The peculiarity is that the smoking chamber, located in a vertical plane, was divided into two parts. One part was made in the form of a Laval nozzle, dividing it into smoking zones, and the second was made in a conical shape, with a zone of saturation of the product with smoking components located here. The flared portion of the Laval nozzle was used to create a porous structure. Behind it, a steam valve, an evacuation zone and a zone of action of an electrostatic field were placed in series. In the area of the electrostatic field, corona electrodes were placed, which ensure the action of the electrostatic field. The cone-shaped lower part, with a dividing device - a granulator located in it, was used to saturate the product with smoking components. Also, an extruder with an injection screw and a feed hopper is vertically mounted on the smoking chamber. Figure 1 shows a general view of the installation for obtaining smoked products with a developed structure and external supply of smoke.

Installation (fig. 1) works as follows. A vacuum is created in the smoking chamber using a vacuum pump. Then the initial product from the loading hopper 12 by the extruder 11 and the injection screw 3 is fed to the upper part of the smoking chamber. Reduced pressure creates a sharp expansion effect on the product, moisture evaporates and the product receives a porous structure. Removal of moisture and non-condensed gases behind the apparatus occurs through the perforated surface to the vacuum pump.

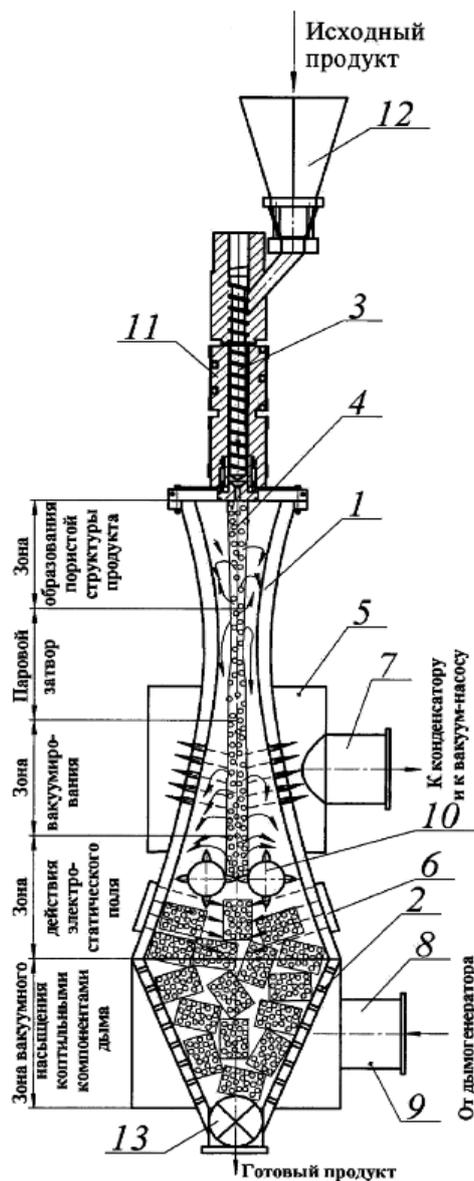


Figure 1. Scheme of the installation for obtaining smoked products with a developed structure and external supply of smoke:

- 1. – Laval nozzle; 2. – the lower part of the nozzle; 3. – delivery auger; 4. – product in the form of a bundle; 5, 9. – casing; 6. – corona electrodes; 7. – connecting pipe; 8. – branch pipe of the smoke generator; 10. – dividing mechanism; 11. – extruder; 12. – loading hopper; 13. – airlock.

The formed rope 4 of the product moves to the dividing mechanism 10, with the help of which the product is granulated into equal pieces. At the same time, smoke is supplied to the lower part of the cone of the Laval nozzle 2 by a smoke generator, which fills the pores of the product. It is necessary to remove air from the pores of the product at the stage of evacuation. With the help of the discharge electrodes 6, an electric field is created, under the influence of which the deposition of smoking components on the surface of the product is carried out. The same field prevents the penetration of smoke into other areas of the smoking chamber. The final stage is the unloading of the finished, smoked granular product from the installation using the sluice gate 13.

The advantages of the proposed installation are that it is located in a vertical plane made of a Laval nozzle and a conical part, it makes it possible to carry out sequentially the processes of forming the porous structure of the product with simultaneous removal of steam, air and non-condensable gases from the pores by evacuation and continuous smoking in an electrostatic field,

which provides an increase in the reliability of saturation with a smoke aroma throughout the volume of the product, and thereby improve the quality of the product, as well as, due to the vertical arrangement of the installation, save production space.

It should be noted that the low porosity of the raw material (tail fat) prevents the movement of smoke (steam). This fact creates large hydraulic resistances, and at the same time, the intensity of the smoking process and, accordingly, the quality of the finished product decreases. Perhaps the preliminary grinding of fat tail fat, before it is fed into the receiving hopper of the preliminary smoking device, would provide an intensive supply of smoking components to the inner layers of the processed product.

In this regard, an interesting technical solution, which, like the previous one, was proposed by scientists from the Voronezh State University of Engineering Technologies, presented in the source [4]. The technical objective of this invention is the development of an installation for obtaining smoked products with a developed structure and internal supply of smoke, which makes it possible to increase the rate of directed deposition of smoking components on the inner surfaces of the pores of the product, to ensure the continuity of the combined process of creating a product with a developed structure and the smoking process, to purify smoking smoke from carcinogenic components, to improve the quality of the product due to the deeper penetration of the smoke components of smoke, purified from carcinogenic substances into the pores of the product.

The novelty of the technical solution of this invention lies in the fact that in the installation for obtaining smoked products (fig. 2), namely on the smoking chamber, a co-extruder is vertically located, at the base of which an insert is coaxially located below the injection screw in the central channel, through which the smoke-air supply pipe passes. mixtures. At the same time, a chamber with corona electrodes is additionally installed in the smoke supply system, the inlet pipe of which is connected to the active nozzle of the ejector, and a dividing-packing device (granulator) is installed directly behind the Laval nozzle.

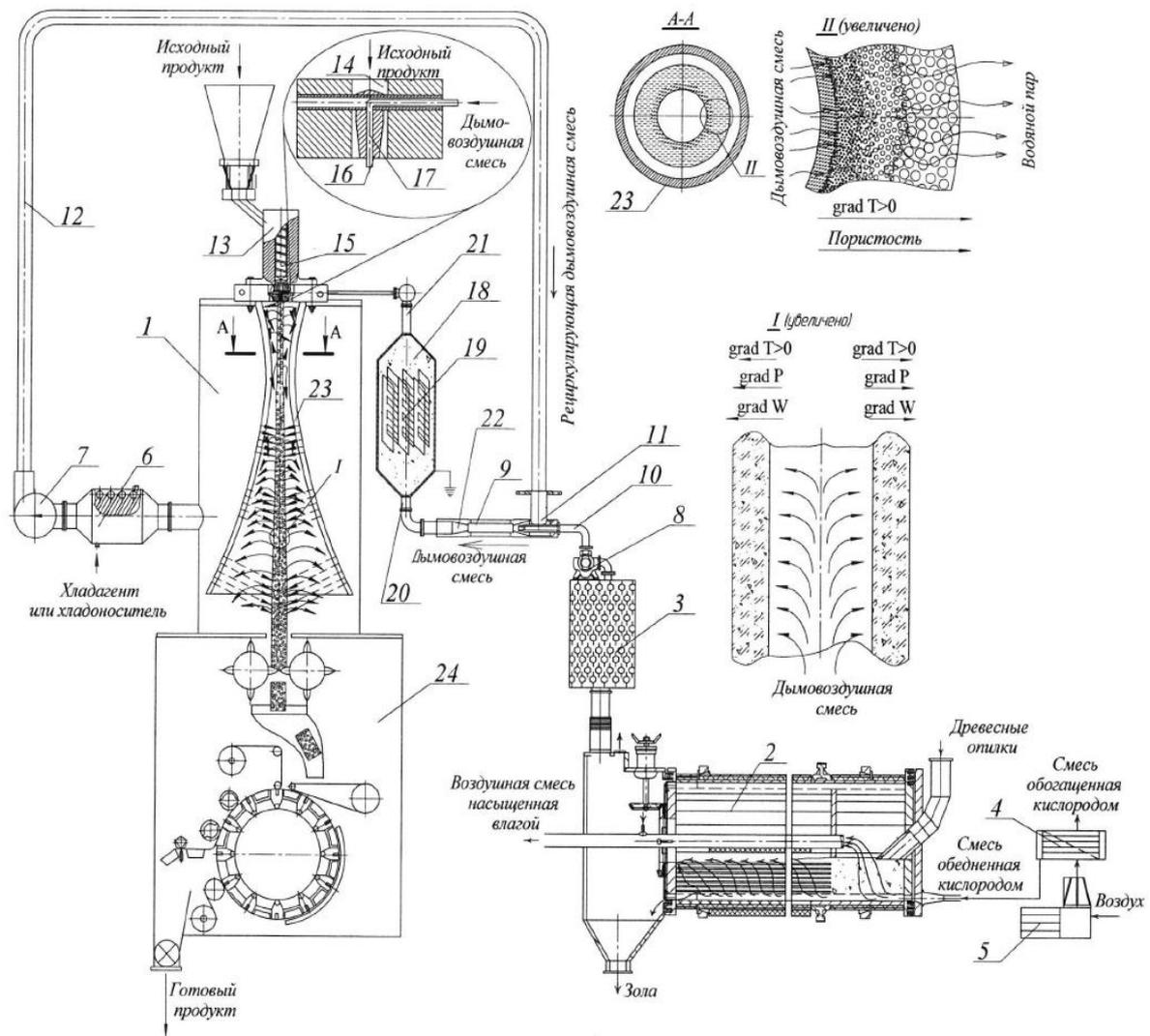


Figure 2. Scheme of the installation for obtaining smoked products with a developed structure and internal supply of smoke:

- 1. – smoking chamber; 2. – smoke generator; 3. – filter; 4. – membrane apparatus; 5. – air heater;
- 6. – capacitor; 7, 8. – pumps; 9. – ejector; 10. – passive nozzle; 11. – mixing chamber; 12. – recirculating pipeline; 13. – co-extruder; 14. – central channel; 15. – delivery auger; 16. – insert;
- 17, 21. – branch pipes; 18. – camera; 19. – corona electrodes; 20. – inlet branch pipe; 22. – injection nozzle; 23. – nozzle in the form of Laval; 24. – granulator-packer

The technical result of the invention [4] is to increase the rate of directed deposition of smoking components on the inner surfaces of the pores of the product, in the continuity of the combined process of creating a product with a developed structure and the smoking process, as well as in the purification of the air-smoke mixture from carcinogenic components. At the same time, an increase in the quality of the product is expected due to a deeper penetration of the smoking components of the smoke, purified from carcinogenic substances, into the pores of the product.

The principle of operation of the installation in Figure 2 is as follows. At the initial stage, nitrogen is generated, obtained by the method of barometric membrane air separation on semipermeable membranes. An example of such a membrane is a cermet-based membrane. The pressure in the inert gas generator 3 is within 0.5...4 MPa. This pressure is achieved by a

compressor, which is built into the air heater 5. In order to achieve intensification of air separation on the membranes and more effective removal of moisture from sawdust, the flow is heated in the zone of their heating and drying. After the membrane-type inert gas generator 4, the air mixture enriched with nitrogen is directed into the channel nozzles of the drum smoke generator 2. Wet sawdust is loaded into the smoke generator 2 through a locking type metering unit, pump 7 and condenser 6 are started. After filling the drying zone with sawdust, they are heated to a temperature 180...190°C. At the same time, enrichment of the air mixture with nitrogen through channel nozzles is achieved. Due to the high nitrogen content in the air mixture, the sawdust dehydration process is intensified. This is explained by the formation of associated groups of moisture and nitrogen molecules, where gas molecules act as a carrier of vapor molecules from the evaporation surface to the space of the smoke generator 2 body free from sawdust, and also "bombard" the product, weakening the forces of interaction between molecules at the points of contact. At the places of collision of molecules, the pressure becomes higher than the ambient pressure, and with an increase in the rate of evaporation of moisture, the pressure difference at the interface also increases. At the same time, the total pressure in the medium increases, which means that the value of heat and mass transfer also increases. The moisture removed from the sawdust is removed from the smoke generator body.

The sawdust moved due to the rotation of the body of the smoke generator 2 through a segment-shaped hole from the pre-drying zone to the dry distillation zone is heated by heating elements in the form of cylindrical ferromagnetic rods to a smoldering temperature, for example, 290...300°C. The rods are heated as a result of the generation of heat in them (according to the Joule-Lenz law) as a result of the induction of eddy currents on them from the intense electromagnetic radiation of the tires and the inductor using a special generator (not shown) of powerful high-frequency currents.

In this zone, under conditions of limited access of oxygen, provided, on the one hand, by its reduced content in the air mixture by removing it in a membrane type 4 inert gas generator, and on the other hand by a locking flap, smoke is formed as a result of dry distillation of sawdust with constant joint mixing of sawdust and cylindrical ferromagnetic rods. The resulting smoke is removed through the peripheral (when they are in the upper position) openings, and the resulting ash is discharged into the unloading hopper.

From the smoke generator 2, the smoke is sucked out through the filter 3, in which it is simultaneously cooled and cleaned from carcinogenic components by the pump 8 and is pumped into the ejector 9 under a pressure in the range of 0.12...0.13 atm, at a high speed passes through the passive nozzle 10 of the ejector 9 and is pumped into the smoking chamber 1 through the chamber 18, equipped with corona electrodes 19. In the chamber 18, the smoke, passing through

the gaps between the corona electrodes 19, is intensely ionized under the action of the electrostatic field. In the smoking chamber 1 with the help of the pump 7, a vacuum of 0.06...0.05 atm is maintained. By means of the injection screw 15, the initial product is fed through the central channel 14 into the peripheral coaxial channel, in which, under the action of the turns of the screw 15, it moves to the outlet annular hole formed by the extruder body 13 and the insert 16. When the initial product enters through the coaxial peripheral channel and outlet through the annular hole into the vacuum space of the smoking chamber 1 of the product, moisture begins to evaporate intensively from it, its rapid dehydration occurs and a highly porous structure is formed with the formation of a tubular dried frame. Simultaneously, the smoke under pressure in the chamber 18 is fed through the nozzles 21 and 17 into the inner cavity of the tubular frame of the product, intensively fills the vacuumized cavities and pores in the product intended for smoking, thereby achieving the effect of directional smoke movement, with the combined use of electric potentials. Due to electrostatics, the smoking components of the smoke are deposited on the surface of the pores of the product, and due to vacuum they are filtered through the product, which ensures its uniform and intensive smoking. Upon reaching the tubular dried frame of the narrow part of the Laval nozzle 23, a highly developed uniformly distributed porous structure is finally formed. The formed rope of product is transferred to a separating-packing device (granulator) 24 and is discharged from the installation by means of a sluice gate. The exhaust smoke that has passed through the product frame is separated from the moisture removed from the product during the formation of its porous structure using the condenser 6, and moves through the recirculating pipeline 12 into the passive nozzle 10 of the ejector 9 for reuse in the smoking process.

According to the patent [4], the installation shown in Figure 2. has the following advantages:

- location in the smoking chamber around the outlet, a vertically located device for feeding the product into the smoking chamber in the form of a co-extruder, a nozzle in the form of a Laval nozzle, provides the creation of a steam seal separating the zones for feeding the product into vacuum and smoking it, which contributes to the uniform and high-quality formation of the porous structure of the extrudate;
- the connection of the central nozzle of the co-extruder with the chamber equipped with corona electrodes, and its inlet nozzle is connected to the active nozzle of the ejector, allows for high-quality preparation of the smoke-air mixture and intensifies the process of deposition of smoking components on the product in an electrostatic field using a vacuum;

- installation of a dividing-packing device directly behind the nozzle at the bottom of the smoking chamber allows packing the finished product in a vacuum environment, which facilitates its long-term storage.

An analysis of the advantages and disadvantages of the above installation (fig. 1.3.2) from the perspective of implementing the technology recommended in this work leads to the conclusion that it is advisable to improve the smoking unit by eliminating electrostatic effects in the process of saturating the product with smoking substances, due to its low efficiency at a fairly high cost and complication of the installation, since pre-blanching and chopping fat tail fat is used as an object of smoking, which in itself intensifies diffusion processes, due to the developed internal structure of the semi-finished product supplied for smoking, which is justified by the author in staged experiments.

According to the latest literature data [5], it is advisable to obtain the finished product in granular form with a protective coating, which is supposed to be substantiated and implemented as a result of this study.

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