

UDC 641.1 + 641.53
DOI <https://doi.org/10.32782/tnv-tech.2024.2.15>

FEATURES OF MECHANICAL DETAILING EQUIPMENT IN THE RESTAURANT BUSINESS AND FOOD INDUSTRY

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The article describes the features of mechanical grinding technological equipment. The paper examines the peculiarities of the interaction of mechanical technological equipment with food raw materials and food products and gives an overview of the application for various technological processes in the food industry and restaurant establishments. Despite the large number of scientific works devoted to the topic of technological equipment, in particular mechanical equipment, in Ukraine this is an insufficiently covered topic that needs research, given the current conditions in the national economy. The structure and principles of operation of machines for grinding coffee, grinding mechanisms and wiping machines for restaurants are considered. Depending on the nature of the forces acting on the product, the following types of crushing are distinguished: crushing, splitting, breaking, grinding, cutting, impact. The named methods have different degrees of compression and shear deformations. Grinding crushes hard and brittle materials. Crushing deforms the entire volume of the material, and when stress values that exceed the compressive strength limit are reached, the material breaks. Grinding is usually carried out under the influence of a combination of forces: crushing and abrasion, abrasion and impact, etc. The cutting process is divided into cutting and spraying. Cutting is used for

grinding semi-solid and plastic materials. During cutting, the parts of the product are given a given shape and size, that is, unlike crushing, the process is controlled. The use of technological mechanical equipment with other physical methods and energy carriers makes it possible to intensify technological processes, reduce the cost of finished products, as well as increase the nutritional and biological value of raw materials, semi-finished products and finished products. The course of the grinding process depends on the following factors: the structure and physical and mechanical properties of the products, structural and geometric indicators of the working bodies and the nature of their movement, kinematic and dynamic parameters of the grinding equipment. Each product has its own structure, which determines the method of grinding. The physical and mechanical properties of the product affect the nature of its destruction at the point of contact with the working body.

Key words: technological equipment, coffee grinding machines, grinding mechanisms, wiping machines, restaurants.

Криворучко М. Ю., Антоненко А. В., Неїленко С., М., Михайлик В. С., Форостяна Н. П., Тонких О. Г. Особливості механічного подрібнювального устаткування в ресторанному бізнесі та харчовій промисловості

У статті описано особливості механічного подрібнювального технологічного устаткування. У роботі розглянуто особливості взаємодії механічного технологічного устаткування з продовольчою сировиною та харчовими продуктами та дано огляд застосування для різних технологічних процесів у харчовій промисловості та закладах ресторанного господарства. Незважаючи на велику кількість наукових праць, присвячених темі технологічного обладнання, зокрема механічного устаткування, в Україні це недостатньо висвітлена тема, яка потребує дослідження, враховуючи сучасні умови в національній економіці. Розглянуто будову та принципи дії машин для подрібнення кави, розмелювальних механізмів та протиральних машин для закладів ресторанного господарства. Залежно від характеру діючих сил на продукт, розрізняють такі види дроблення: роздавлювання, розколювання, розламування, розтирання, зріз, удар. Названі способи мають різну ступінь деформацій стискання та зсуву. Дробленням подрібнюють тверді та крихкі матеріали. Роздавлювання деформує увесь об'єм матеріалу, і під час досягнення значень напружень, які перевищують межу міцності до стискання, відбувається руйнування матеріалу. Зазвичай подрібнювання здійснюється впливом комбінації зусиль: роздавлювання і стирання, стирання і удар та ін. Процес різання поділяється на розрізання та розпилення. Розрізання застосовують для подрібнення напівтвердих і пластичних матеріалів. Під час розрізання частинам продукту надається задана форма та розміри, тобто, на відміну від дроблення, процес керований. Застосування технологічного механічного устаткування з іншими фізичними методами та енергоносіями дає змогу інтенсифікувати технологічні процеси, знизити собівартість готової продукції, а також підвищити харчову та біологічну цінність сировини, напівфабрикатів і готової продукції. Перебіг процесу подрібнення залежить від таких чинників: структура та фізико-механічні властивості продуктів, конструктивні та геометричні показники робочих органів і характер їх руху, кінематичні та динамічні параметри подрібнювального устаткування. Кожний продукт має свою структуру, яка визначає спосіб подрібнення. Фізико-механічні властивості продукту впливають на характер його руйнування в місці контакту з робочим органом.

Ключові слова: технологічне устаткування, машини для подрібнення кави, розмелювальні механізми, протиральні машини, заклади ресторанного господарства.

Introduction. Grinding is the process of dividing the product into particles of a given size under the action of mechanical forces due to deformation. Grinding is intended to speed up heat treatment processes, achieve the necessary technological effect, and facilitate dosing. There are two types of crushing: crushing without giving the crushed products a certain shape, and cutting, during which the crushed material is given the desired shape.

Depending on the nature of the forces acting on the product, the following types of crushing are distinguished: crushing, splitting, breaking, grinding, cutting, impact. The named methods have different degrees of compression and shear deformations. Grinding crushes hard and brittle materials. Crushing deforms the entire volume of the material, and when stress values that exceed the compressive strength limit are reached, the material breaks.

Formulation of the problem. The destruction of the material during splitting occurs at the point of greatest load under the influence of the wedge-shaped working body. Energy expenditure for splitting the body is less than during childbirth.

Breaking occurs as a result of bending forces. The transformation of the material into a dispersed state during abrasion is carried out under the action of compressive, tensile and shearing forces.

During the impact, the working body has a given initial speed before contact with the material and dynamic destruction of the material occurs. The dynamic load can be concentrated and distributed over the entire volume of the body and get a result similar to splitting and crushing.

Grinding is usually carried out under the influence of a combination of forces: crushing and abrasion, abrasion and impact, etc. The cutting process is divided into cutting and spraying. Cutting is used for grinding semi-solid and plastic materials. During cutting, the parts of the product are given a given shape and size, that is, unlike crushing, the process is controlled.

Solid materials are ground into a powder by spraying. The mentioned methods of grinding are widely used in the technologies of restaurant products: during the production of breadcrumbs, ground coffee, crushed nuts, puree-like masses from cooked vegetables, fruits, sour milk cheese, during cutting of raw vegetables, fruits, meat, fish, bread, cheese and other gastronomic products.

The aim of the study. The purpose of the work is a scientific study of the principles of operation of mechanical equipment for restaurant establishments.

The object of the study is mechanical grinding equipment and the principles of its operation.

The subject of research is coffee grinding machines, grinding mechanisms, wiping machines.

Analysis of recent research and publications. Scientific substantiation and development of competitive technological equipment is an urgent task, the solution of which will allow expanding the range of food products and obtaining products with specified properties.

The research of the following domestic and foreign scientists made a significant contribution to the solution of fundamental issues of technological equipment for the creation of food products: O.O. Grinchenko, A.B. Horalchuk, A.M. Dorokhovych, I.Yu. Zhigalenko, A.V. Ziolkovska, M.B. Kolesnykova, H.M. Lysyuk, L.P. Malyuk, L.M. Mostovoy, N.Ya. Orlova, M.I. Peresichny, P.P. Pivovarova, N.V. Prytul'ska, G.B. Rudavska, M.R. Ennis, J.C.F. Murray, G.O. Phillips, W.C. Weling, P.A. Williams et al. [1–10].

Presentation of the main research material. All grinding equipment used in restaurants can be classified according to the following basic features.

- 1) by functional purpose:
 - for grinding solid food products (grinding machines and mechanisms);
 - for grinding soft food products (wiping machines and mechanisms);
 - for cutting food products (vegetable cutters, meat grinders, meat grinders, etc.);
- 2) according to the structure of the work cycle: periodic and continuous action; – according to the placement of working bodies: vertical and horizontal;
- 3) by type of drive: with individual drive and as variable mechanisms.

There are household and professional coffee grinders. In household machines, coffee grinding occurs due to the rapid rotation of a rotor with a knife, therefore, such coffee grinders are called rotary or knife grinders.

For better grinding of coffee, restaurant establishments install grinding coffee grinders. The principle of coffee grinding in them is different: the grains are compressed and ground between rotating and stationary relief surfaces (grinders).

Rotary (knife) coffee grinders are advisable to use in restaurants where coffee is brewed in Turks. If coffee is prepared using professional coffee machines, it is not recommended to use a rotary coffee grinder for grinding coffee.

As a result of the design features of rotary coffee grinders, the resulting powdery coffee mixture contains particles that are not uniform in size, which does not allow to fully reveal the taste properties of the finished drink.

Advantages of rotary coffee grinders:

- low price;
- reliability.

Disadvantages of rotary coffee grinders:

- uneven particle size after grinding;
- the degree of grinding is regulated by the duration of the process;
- small volume of the working chamber;
- heating of products due to the high speed of rotation of the knife;
- the grain structure is significantly damaged, which worsens the taste of the drink (bitter aftertaste);
- impossibility of dosing portions.

Rotary coffee grinders can be used to grind sugar, nuts, salt, pepper, breadcrumbs, etc. When choosing a rotary coffee grinder, take into account the following features:

- the presence of a timer;
- the capacity of the working chamber;
- material of working bodies;
- the material of the working chamber and the body of the machine;
- type of working chamber;
- power of the electric motor.

The degree of coffee grinding in rotary coffee grinders depends on the duration of the process. Sometimes manufacturers of such machines equip them with timers. However, with the help of a timer, it is difficult to achieve a constant degree of grinding of different portions.

The working bodies (knives) of rotary coffee grinders are made of stainless steel. Knives are single and double, straight and curved. Single straight knives do not stir the product while the machine is running. Curved knives mix the product and the degree of grinding is more uniform. In double curved knives, one blade can bend down and the other up, which ensures volumetric mixing of coffee.

It is not recommended to choose rotary coffee grinders with straight knives. The working chambers and housings of rotary coffee grinders are made of stainless steel or plastic. It is recommended to choose a rotary coffee grinder with a steel working chamber and body, as plastic particles can enter the product.

Additional features of rotary machines for grinding coffee:

- an inclined working chamber – according to the manufacturers of such machines, this creates conditions for more uniform grinding of coffee;
 - hopper for ground coffee – not often found in rotary coffee grinders, but it greatly facilitates the operation of the device;
 - fixing the switch – makes it easier to work with the device under the condition of regular use;
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- blocking operation in the absence of a cover – prevents injury and uncontrolled spread of ground coffee from the working chamber to the room;
- portion dispenser – makes it easier to work with the device, but there is a high probability of clogging the dispenser with ground coffee;
- pulse mode – the speed of rotation of the knife depends on the pressure on the switch;
- silence – according to some manufacturers, their models of rotary coffee grinders create less noise during operation, but this is not always confirmed in practice;
- rubber feet;
- protection against engine overheating;
- protection against removing the cover during device operation.

In grinder coffee grinders, the grains are crushed as a result of crushing, splitting and abrasion during contact with the moving and stationary grinders. Unlike rotary coffee grinders, the power of splitting coffee is more important in millstones. The friction between the grinders and the coffee beans is negligible, so the coffee does not overheat. In grinding coffee grinders, the duration of operation does not affect the size of the particles in the mixture. The degree of grinding is regulated by changing the distance between the millstones.

Flat-parallel grinders are a classic variant of working organs for grinding coffee. By design, flat millstones are disks with a relief on one side. The upper millstone is immovably fixed to the body, and the lower one to the shaft of the electric motor. Coffee beans fall into the opening of the upper fixed grinder, are crushed into large particles by blades from the inner surface of the discs. Further, the centrifugal force pushes the particles to the edges of the discs, where they are crushed by a larger number of blades, but with smaller sizes. When the particle size becomes smaller than the space between the grinders, the particles flow outside the grinders to the ground coffee hopper.

Conical grinders are installed in newer models of coffee grinding machines. Conical working bodies consist of two cones: an outer stationary cone and an inner conical rotating one.

The material of the working organs affects the taste of the coffee, the uniformity of the coffee powder and the durability of the grinder. Millstones are made of the following materials: hardened steel; cast iron; ceramics (common in automatic espresso coffee machines); stone (devices for manual grinding of coffee).

To slow down the wear of the working surface, the millstones are covered with protective coatings, such as titanium. Advantages of cast iron millstones: strength, impact resistance, wear resistance, relatively low price. Disadvantages of cast-iron grinders are: cast-iron grindstones gradually grind, the shavings get into the coffee and cause a metallic aftertaste; the porous structure of cast iron determines the ability to absorb aromatic substances, so the taste and aroma characteristics of different types of coffee can be mixed. Advantages of millstones made of hardened steel: strength and relatively low price. The disadvantage of steel millstones is faster wear, compared to cast iron ones. To increase strength and wear resistance, steel millstones are manufactured with a titanium coating. The smooth surface of the titanium coating does not adsorb aromatic substances. The cost of machines with such mills is higher.

Ceramics are polycrystalline materials and products made from them, which consist of compounds of non-metals of III-VI groups with metals or with each other, and which are obtained by forming and firing the raw materials. The advantages of ceramic millstones are: the strength of ceramics is not inferior to diamonds, therefore the millstones are sharpened for a long time and the grinding quality is better,

compared to millstones made of other materials; ceramic millstones, unlike steel or cast iron, do not corrode from moisture; and ceramic grinders create less noise during operation. Disadvantages of ceramic grinders: ceramic grinders are strong, but fragile, and break when hit or hit with coffee by hard impurities, such as stones. In terms of cost, coffee grinders with ceramic grinders occupy an intermediate position between cast iron and steel ones with a coating. Stone millstones are an alloy of ceramics and corundum. They are resistant to impacts and abrasion, coffee has no extraneous aftertaste. With the help of these grinders, you can get coffee powder with ultra-fine grinding.

The approximate duration of normal operation of the grinder depends on the amount of ground coffee: steel grinders – 250...500 kg of coffee; ceramic grinders – up to 1000 kg of coffee.

Grinding mechanisms with a conical working body are designed for grinding crackers, spices and other solid food products. The mechanism is powered by the drive of a universal kitchen machine, and has the form of an aluminum cylindrical body with a loading funnel. Inside the case there is a working body, which consists of an auger, rotating and stationary millstones. The auger and millstone are fixed on the horizontal drive shaft.

The auger ensures a smooth flow of the product to the grinding surfaces of the millstones. Millstones are turned towards each other by conical surfaces with spiral protrusions of a triangular profile of variable height. From the center to the edge, the height of the protrusions decreases, and their number increases. Such a working surface allows you to increase the degree of grinding and ensure uninterrupted advancement of the crushed product. The degree of grinding depends on the gap between the grinding surfaces. The clearance can be changed by axial movement of the grinder using an adjusting nut that is screwed onto the cylindrical shank of the grinder.

In the adjusted position, the millstones are fixed with a union nut. The minimum gap between grinding surfaces is 0.2 mm. The mechanism is actuated by the drive, which is connected to it with the help of a shank. The discharge opening of the masses is the form of a vertical tray.

Rubbing is used to prepare puree-like products. The rubbing process consists in crushing or separating the mass of fruit and vegetable raw materials from ballast fabrics on sieves with holes up to 5 mm in diameter.

The following technological requirements are put forward to wiping machines: ensuring a homogeneous and sufficiently fine dispersed composition of the wiped product; minimum amount of waste; high productivity and low specific energy consumption, low metal content, simple structure; convenience in operation and maintenance; ensuring a stable mode of wiping; the possibility of selecting the rubbed semi-finished product by fractions.

Depending on the method of action on the product, machines are used for grinding cooked products, which are divided into three groups.

The first group includes machines in which the product is crushed due to high-frequency oscillations in combination with shear. The machines are designed for fine grinding of cooked products. Finely dispersed food pastes obtained after grinding from cheese, cooked vegetables, cereals, meat, and fish are mainly used in children's and dietary food.

The second group is machines in which the product is cut by the edges of the sieve and pushed through its holes. These machines are used to prepare puree from boiled potatoes, vegetables, meat and fish products, cheese and other products.

The third group is machines in which the product is crushed and mixed with a rotating blade. Machines of this group are used to prepare mashed potatoes directly in the digester.

Shovel wiping machines. These machines are used to obtain puree-like products from boiled vegetables, cereals, meat, fish products, sour milk cheese.

The grinding process consists in the fact that the product loaded into the working chamber is crushed on a flat screen with a rotating blade, and at the same time it is pushed through the holes of the screen, the edges of which additionally cut the product.

The working bodies of blade grinding machines have the same structure. They consist of a rotating blade (blade rotor) and a stationary screen (grid).

The machine consists of a body and a welded frame, in the middle of which there are a reversible electric motor, a V-belt transmission and a drive shaft.

The loading hopper is installed on the body and attached to it with two hinged bolts. The upper conical part of the hopper serves as a loading funnel for the product, the lower cylindrical part is a working chamber in which the rotor rotates. A hatch for unloading waste is located on the cylindrical part of the hopper. The hatch is closed with a lid with an eccentric clamp and a handle. A container is provided for waste collection. Replaceable rotors for processing various products are attached to the drive shaft.

Interchangeable grids are immovably installed in the housing and are prevented from rotating by the working chamber. The adjustment of the gap between the stationary grate (sieve) and the rotating rotor is carried out through an intermediate cup, which is fitted along the height of the shaft with a nut and fixed with a screw. On the same cup, below the grate, a discharger is fixed, which throws the ground product out of the body into the unloading hopper.

There are blades on the rotor, the angle of inclination of which during clockwise rotation ensures the pressing of the ground product against the sieve, and when rotating counterclockwise – the advancement of the ground residues up the cylindrical wall of the hopper to the waste disposal hatch.

Depending on the product being ground, the combination of working bodies may be different: a bladed rotor and a sieve with 3 mm holes or a bladed rotor and a sieve with 1.5 mm holes.

Let's consider machines for preparing mashed potatoes in digestive boilers. The machine includes a digester and a drive mounted on a three-wheeled cart. Two wheels are mounted on fixed axles, and the third can rotate, which ensures the maneuverability of this mechanism.

A special device fixes the drive relative to the boiler. A telescopic column consisting of two pipes is mounted on the cart. The inner pipe can be moved vertically using a lifting mechanism. In the upper part of the pipe, the drive is fixed on the stand, on the casing of which the control station and stop are installed. The outer pipe is fixed on the cart and has a handle for moving the cart and a flywheel of the lifting device.

The head of the beating mechanism has a bevel gear reducer, the horizontal shaft of which is connected to the drive shaft. On the vertical shaft there is a coupling for connecting the blade. Blade frames coincide with the contours of the boiler. The transverse plates of the frame are sharpened and bent at a certain angle. During the grinding of potatoes and whipping of mashed potatoes, the boiler is closed with a special lid that has clamps.

After the potatoes are boiled until ready, and the broth is drained, a cart with a manual drive is rolled up to the boiler. The drive is raised up to the stop with the help of a

flywheel, the beater blade is installed and lowered to the lowest position. The ready-to-use drive is turned on with the boiler cover closed. After 2.5 minutes, recipe components are poured into the boiler through a funnel. The total time for preparing mashed potatoes is 5 minutes. At the end of the work, the lid is removed from the boiler, and then the stirring blade. Next, disconnect the cart from the boiler by pressing the pedal.

The working body of the machine rotates only around its own axis. In some models, the blade simultaneously rotates around its own axis and around the axis of the boiler.

Conclusions. The grinding process is characterized by the degree of grinding – the ratio of the average size of a piece of product before and after grinding. According to the degree of grinding, this process is divided into five types. Coarse grinding is usually done by cutting. Simultaneous or sequential separation of the product in one or more planes may be applied. In medium grinding, crushing processes are involved, sometimes with the participation of cutting. Crushing is usually carried out by impact with the use of various shaped working bodies. If cutting is used, then the working organs have the form of disks, plates or knives in the shape of a sickle. Medium grinding can be carried out with the help of a pair of cutting working organs: a rotating cross-shaped knife and a fixed knife grid. Fine and fine types of grinding are carried out by crushing and cutting, as a result of which a homogeneous mass is obtained, which in terms of structural and mechanical properties is significantly different from the initial product. The working bodies for this process are high-speed rotating sickle-shaped knives, toothed discs, knife-grid sets. The course of the grinding process depends on the following factors: the structure and physical and mechanical properties of the products, structural and geometric indicators of the working bodies and the nature of their movement, kinematic and dynamic parameters of the grinding equipment. Each product has its own structure, which determines the method of grinding. The physical and mechanical properties of the product affect the nature of its destruction at the point of contact with the working body. Structural and geometric parameters of the working body, kinematic and dynamic characteristics of the machine determine a certain degree of grinding, quality and properties of the ground material.

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