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APPLICATION OF GRANULATION TECHNOLOGY IN VARIOUS INDUSTRIES

Abstract

Science and practice proved the high efficiency of granulated mixed fodders. This article presents an overview of granulation technologies for various industries. This article discusses the application of granulation technologies in various industries. The processes of granulation are mass technological processes currently used in a wide range of industries: feed industry, food industry, pharmaceutical industry, fertilizer production, polyethylene, metal production, mining, etc. A wide range of different materials are granulated, including chemicals, iron ore, mixed fodder, and much more. Granulation is a process of pressing or shaping a material in the form of granules.

Granulation is widely used in the production of pigments, dyes, synthetic detergents, catalysts, plastics, soot, chemical reagents, etc. The use of granular raw materials in the metallurgical industry helps not only to mechanize processes, but also to increase their intensity by increasing the contact surface of interacting media. Granular fertilizers retain their properties for a long time. In the mining industry, granulation processes are used at the stage of preparation and enrichment of raw materials and release of the finished product.

Particular attention is paid to the feed industry. Granulation allows to ensure stable homogeneity, to improve sanitary and hygienic parameters, to increase nutritional value, to increase the storage period, improve the physical properties. However, despite all the advantages, the existing granulation production lines have a relatively high productivity and, at the same time, a high energy intensity. In this regard, this article proposes a technology for improving the granulation of mixed fodders. According to a preliminary literary review, It should be concluded that improving the technology of the granulation process for feed production is a topical issue in the feed industry today. The development of technology for improving the granulation process, by obtaining a separate expanded product in the granulation line, will not only improve nutritious and sanitary quality of mixed fodder products, but also increase their productive effect. And the main advantage is the reduction of energy costs. But, the effectiveness of this technology will be confirmed in the future, based on in-depth studies and obtained results.

Keywords: *technology of granulation, pharmaceutical industry, production of polymer and polypropylene, production of biofuel, production of fertilizers, chemical industry, manufacture of metal, feed industry, reduce energy consumption, mixed fodder.*

Overview

The processes of granulation are mass technological processes widely used at present. Granulation technology have been used by a wide range of industries, from the feed industry, pharmaceutical industry to the fertilizer and the mineral processing industries. Granulation technology is the process of compressing or molding the material into the shape of a pellet and granules. Wide ranges of different materials are pelletized including chemicals, iron ore, mixed fodders and more. The granulation technology combines mixing of the raw material, forming the pellet and a thermal processing baking the soft raw pellet to the hard spheres. Granules have a good mobility, they do not adhere to the surface of the hopper, do not dust during transportation and packaging. The use of granulated intermediate products allows to intensify the technological process, improves the sanitary quality.

On the presented industries there's a difference in numbers, 5 - 10%. This difference depends on the characteristics of the industry, region, country, year, performance, the volume of production and many other factors. The table shows the averaged numbers.

Table 1 - Application of granulation technologies in various industries, %

1	Granulation technology in the feed industry is	48 %
2	Granulation technology in the pharmaceutical industry is	32 %
3	Technology of granulation in the production of polymer and polypropylene is	7,2 %
4	Technology of granulation in the production of biofuel is	5,5 %
5	Granulation technology in the production of fertilizers is	2,2 %
6	Granulation technology in the food industry is	2,0 %
7	Technology of granulation in the chemical industry is	1,4 %
8	Granulation technology in the manufacture of metal wares is	1,2 %
9	Others is	0,5 %

Aim of this article

To familiarize with technologies of granulation in various industries. To consider the problems of feed industry for granulation of mixed fodders and ways to solve problems. Consider each branch separately.

1. Granulation technology in the manufacture of metal wares.

Granulation of metal is the production of shaped blanks or parts by pouring molten metal into a special shape, the cavity of which has the configuration of the workpiece or parts. When granulation, the metal is simultaneously cleaned with mechanical separation of scales, oxides, residual molding material, and other foreign particles. In the process of granulation, a special crucible with fine holes is used to mechanically filter the metal melt, and a thermocouple is placed in the side wall of the crucible. The process of granulation is carried out continuously. The metal enters the crucible as the previous portion of metal is released. To prevent access of oxygen to the granulator, the content of the inert gas is constantly maintained in the system. [2].

2. Technology of granulation in the chemical industry.

The basic condition for the successful manufacture of chemical products is a safe manufacturing process and the compliance with strict environmental requirements. At the same time the enormous competitive pressure demands a high economic efficiency. [5]

Processes of building ceramics technology include processing clay raw materials and preparing the mass. There are three main ways of processing raw materials and preparing the mass: semi-dry (moisture content 8-13%), plastic (moisture content 18-26%) and slip (moisture content 45-60%). Semi-dry method of preparation of the mass consists in rough grinding of the raw material, its drying, fine grinding, screening of large inclusions, mixing it with additives and moistening. It is in this method that granulation is realized. Before drying in drying drums, raw materials with high humidity (15-25% for clays and 38-45% for diatomite) should be granulated in order to obtain particles of the same size. Granulated masses after drying in the drying drum differ slightly in humidity fluctuations. [6]

Also in the manufacture of ceramic materials are used the processes of fluidised bed technology.

The processes of fluidised bed technology, for example spray granulation, meet the requirements of the chemical industry in a cost-efficient way. The fluidised bed technology is an efficient process optimally suited for these targets: The high material yield makes the use of expensive raw materials more effective and the improved product properties secures the competitiveness. The fluidised bed technology offers many advantages for processing ceramic materials.

The method for producing lightweight, high-strength ceramic includes heat treatment of the raw aluminum silicate raw material. Then occurs milling and granulation of thermally treated aluminum silicate raw material with constant mixing of the mass and its moistening, drying and sieving of the obtained granules. Then the granules are crushed. Then the final firing of the pellets and the sifting of the burned pellets takes place. [5, 6]

3. Granulation technology in the food industry.

In the food industry, agglomeration is used for a long period of time in order to obtain agglomerates with improved dispersibility of fine powders. It is carried out by granulation. The technology of granulation is also used in the food industry: to produce dishes and products in the form of fillers for ice cream, creams, cheese mass, puddings, jelly, caviar, and also to obtain food granulated product from liquid food products. For example, fruit and vegetable raw materials, balms, tinctures from flowers, cocktails, etc. With the preservation of organoleptic indicators, characteristic of fresh liquid food products, fruits, fruits, berries and vegetables. This technology is as follows. Mingled the liquid food product and a solution of sodium alginate and a thermotropic polysaccharide into which a slightly soluble calcium salt is added. The mixture is granulated at high temperatures. The proposed method allows to obtain a granular product from liquid food products, namely juice, puree, kvass, wine, cider, balms, tinctures from flowers and cocktails. Technology of granulation is used to produce an analogue of natural granular caviar. The essence of it is as follows: the mussel broth obtained with blanching mussels is boiled to a solids content of 10-20%. The cooled broth is mixed with gelatin, sodium caseinate, vegetable deodorized refined oil, a pasty dye is added. The mixture is thoroughly stirred, heated to a temperature of 45-50 °C. and filtered. The formed granules are separated from the oil, washed with water, treated with 0,2% solution of pectin and 0,25% calcium solution of acetic acid. Next, the culinary processing of granules in the protein-oil emulsion, which consists of mussel broth and vitamin-oil mixture. [10]

4. Granulation technology in the production of fertilizers.

Water-soluble mineral fertilizers in granular form have better physical properties. They well retain flowability over time, do not dust, are more effectively used by plants. They are more slowly washed out by soil waters and less degraded in soil, because of the smaller contact surface with its components. Granular fertilizers are produced with granule sizes of 1-6 mm, usually 2-4 mm.

The optimal technology for the production of organic and organo-mineral granules is their granulation in fluidized bed apparatus with jet spraying. The installation works as follows. Preliminarily, the initial slurry passes through a grinding step. The received mass is disinfected. Directly the granulation process takes place in the working chamber of the fluidized bed apparatus. There, a flow of hot air is supplied in an amount providing a stable fluidized bed of granules. [7]

5. Technology of granulation in the production of biofuel.

Wood pellets are small cylindrical pressed wood products with a diameter of 4-12 mm, length 20-50 mm, processed from dried residues of woodworking and sawmill production: sawdust, shavings, wood flour, wood chips, wood dust, etc.

The technology of production of fuel pellets, as well as fuel briquettes, is based on the process of pressing crushed wood waste, straw, husks, etc. Raw materials (sawdust, straw, etc.) enter the crusher, where they are ground to the state of flour. The resulting mass enters the dryer, from it - into a press granulator, where the wood meal is compressed into granules. Compression during pressing increases the temperature of the material, the lignin contained in the wood softens and glues the particles into dense granules. Finished granules are cooled, packed into large big bags (several tons each) or small packaging. Granules are used in boilers for obtaining thermal and electrical energy by burning.

6. Technology of granulation in the production of polymer and polypropylene.

Granulation is the final stage of the technological process for the production of ethylene polymers.

The technology is as follows: the polymer moves continuously using a screw through several heated zones with different temperatures, and is melted under the action of friction and heat. The feed hopper maintains a temperature in the range of 60-115 °C, in the zone of the forming spinner - 180-260 °C. Further, the material is cut with knives, which rotate to lengths of the established length - granules. Hot granules are cooled by water. The technological parameters of granulation (temperature in the zones of the granulator, the speed of rotation of the screw, the degree of compression, the cooling re-

gime) are determined depending on the type and physico-mechanical properties of the polyethylene: density, phase transition temperature, melt flow index.

Granulation solves several problems: removal of residual solvents and impurities; increase of mechanical characteristics; giving commercial qualities for rational use; obtaining a product with various additives. [9]

7. Granulation technology in the pharmaceutical industry.

There are a number of granulation technologies available to pharmaceutical manufacturers. Granulation, the process of particle enlargement by agglomeration technique, is one of the most significant unit operations in the production of pharmaceutical dosage forms, mostly tablets and capsules. [4]

During the granulation process, small or coarse particles are converted into large agglomerates called granules. Generally, granulation commences after initial dry mixing of the necessary powder ingredients along with the active pharmaceutical ingredient, so that a uniform distribution of each ingredient throughout the powder mixture is achieved. Although granules used in the pharmaceutical industry have particle size in the range of 0,2-4,0 mm, they are primarily produced as an intermediary with a size range of 0,2-0,5 mm to be either packed as a dosage form or be mixed with other tablets. [3]

The process granulation depend on particle size of the drug, the type, concentration, and volume of binder and/or solvents, granulation time, type of granulator, drying rate (temperature and time), etc. Blend of powders containing pharmaceutical excipients can be compressed into tablets either by direct compression or after making granules by agglomeration or granulation techniques.

Granulation process can be divided into two types: wet granulation that utilize a liquid in the process and dry granulation that requires no liquid. (figure 1). The type of process selection requires thorough knowledge of physicochemical properties.

Dry granulation uses mechanical compression or compaction to facilitate the agglomeration of dry powder particles, while the wet granulation uses granulation liquid (binder/solvent) to facilitate the agglomeration by formation of wet mass. Forming granules without moisture involves compacting and size reduction of the mix to produce a granular, free flowing blend of uniform size. Dry granulation can be done in two ways: in tableting press or between two rollers.

Wet Granulation. The process of adding a liquid solution to powders involves the massing of a mix of dry primary powder particles using a granulating fluid. The fluid contains a solvent that must be volatile, so that it can be removed by drying, and be non-toxic. Typical liquids include water, ethanol and isopropanol, either alone or in combination.

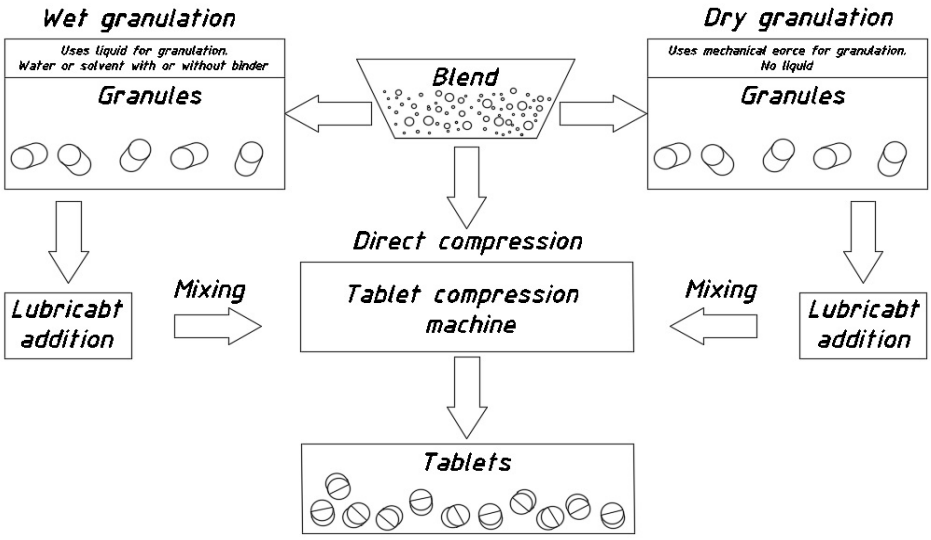

Figure 1 - Ways of granulation in the production of tablets [3]

Among these two techniques, wet granulation is the most widespread granulation technique used despite the fact that it involves multiple unit, which are complex, time consuming, and expensive.

Like any other scientific field, pharmaceutical granulation technology also continues to change, and arrival of novel and innovative technologies are inevitable. Obviously, the pharmaceutical granulation techniques and technologies have improved over the years. Nevertheless, efficient and cost-effective manufacturing methods have always been the keen interest of the pharmaceutical industries. Each technique has its own merits and limitations. [3, 4]

8. Granulation technology in the feed industry.

The feed industry is one of the most competitive industry in the agricultural sector. In 2011, around 734.5 million tons of feed were produced annually around the world. The United States is one of the largest feed producers in 2011-2014. One of the largest Asian feed producers is Charoen Pokphand, a thai company producing 18 million tonnes of compound feed at various locations across East Asia. In Ukraine, the production of mixed fodder is an important branch of agricultural products, which is constantly evolving. [11]

Mixed fodder is balanced mixture, enriched vitamins, minerals fodder, which produce to agricultural and domestic animals in the course of animal husbandry. The main ingredients used in commercially prepared feed are the feed grains, which include corn, soybeans, sorghum, oats, and barley. The amount of grain used to produce the same unit of the conversion of fodders varies substantially. According to an estimate reported by the BBC in 2008, cows and sheep need 8 kg of grain for every 1 kg of meat they produce, pigs about 4 kg. The most efficient poultry units need a mere 1,6 kg of feed to produce 1kg of chicken. Feed grains are the most important source of mixed fodder globally. Also mixed fodder includes hay, straw, silage, compressed and pelleted feeds, oils and grains wheat, oats, barley, legumesand etc. Traditional sources of mixed fodder include household food scraps and the byproducts of food processing industries such as milling and brewing. Material remaining from milling oil

crops like sunflower, soy, and corn are important sources of fodder and is called extraction feed. Mixed fodder may also include premixes, which may also be sold separately. Premixes are composed of vitamins, minerals, chemical preservatives, antibiotics, fermentation products, and other essential ingredients. Because of the availability of these products, a farmer who uses his own grain can formulate his own rations and be assured his animals are getting the recommended levels of minerals and vitamins. Mixed fodder are formulated according to the specific requirements of the target animal. They are manufactured as meal type, pellets or crumbles. [1, 13]

The technology of granulation began to develop in the 1950-1960s passed a period of rapid development in the 70s. From 2010-2012, the share of production of granulated mixed fodder has grown to 70-80% (if we consider the countries of Western Europe, for example, the Netherlands, then up to 90-95% - large feed mills and large holdings). Granulation allows to ensure stable homogeneity of mixed fodder, to improve sanitary and hygienic parameters, to increase nutritional value, to increase the storage period; Improve the physical properties: the parts of the components do not self-segregate, the product and transport losses are reduced during transportation and storage, the efficiency of using storage tanks, silos and vehicles is increased. The indicators of growing mixed fodders are at least 10-15% higher when using granulated mixed fodders. However, despite all the advantages, the existing granulation production lines have a relatively high productivity and, at the same time, a high energy intensity. [8]

Preparation of loose mixed fodders begins hammer mill crushes raw material. Also, feed ingredients are first combined and mixed thoroughly by a feed mixer. Loose mixed fodders comes to bunkers metering section through the receiving device. At the same time the movement of raw materials provides by special conveyors screw. Loose mixed fodders is then weighed on a balance control. After this process, loose mixed fodders is ready for granulation, which is carried out in the respective production line. (figure 2).

Process of preparation of mixed fodder involves several operations such as preliminary milling, weighing, blending feed, and then granulation, drying, or cooling, addition. In the context of granulation, it is important to understand compaction processes to establish desirable granule properties for granulation performance. The wet granulation process must generally achieve the desired granule properties within some prescribed range. However, common to most processes is a specific product size distribution. Size distribution affects flow and segregation properties, as well as compaction behavior. [8]
Granulation of agriculture mixed fodder result in granules from 1.2 mm (shrimp feeds), through to 3–4 mm (poultry feeds) up to 8–10 mm (cows and cattle feeds). The granulation animal feed is done with a granulator. Wet granulation is process whereby small particles are agglomerated, compacted, or otherwise brought together into larger, relatively permanent structures. In wet granulation, granules are formed by the addition of a liquid or steam in loose mixed fodder, which is under the influence of working machine organ. In such instances, a liquid solution that includes a binder matter is required. Fat, molasses, and others is one of the most commonly used binders matter. This process results in the formation of granules. The process can be very simple or very complex depending on the technical specifications, process parameters and the equipment that is available.

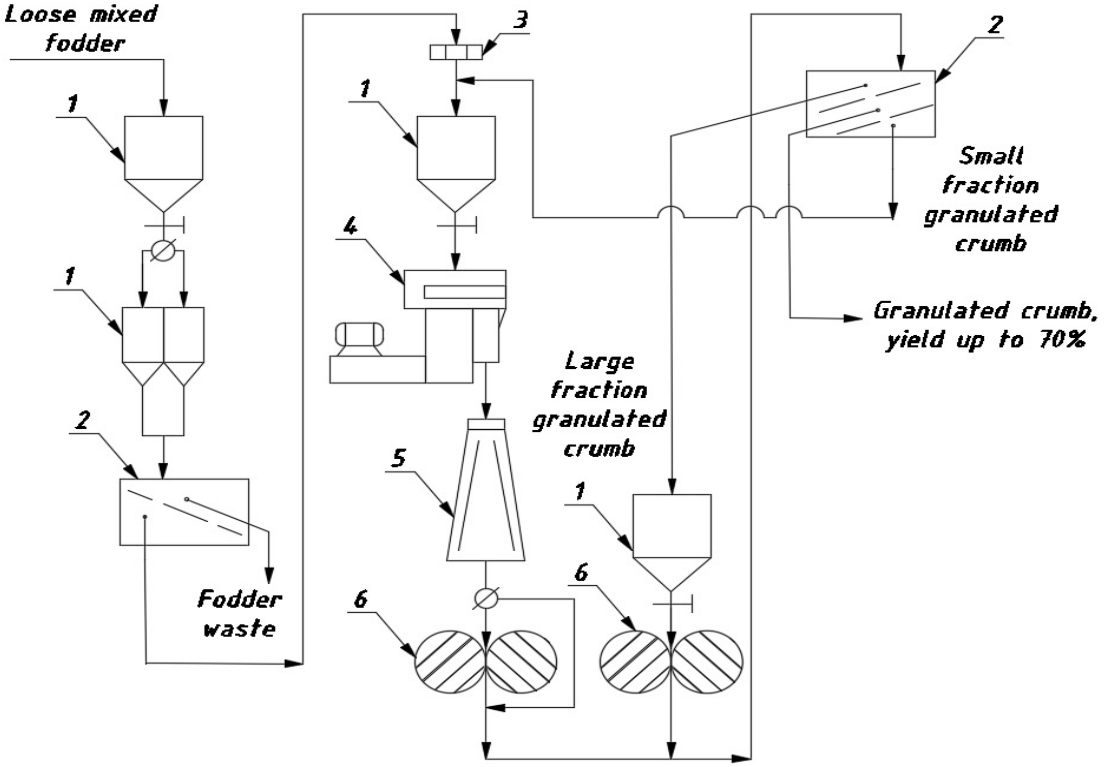

Figure 2 - Scheme of the technology of granulation of mixed fodders [1]
1 - temporary storage bunker; 2 – separator, for the cleaning; 3 - magnetic separator; 4 – granulator; 5 – cooler; 6 - crusher 7 - separator, for product separation

Granulation is done in a compound feed plant, where feed is normally conditioned and thermal treated in the fitted conditioners. The mixed fodder is pushed through the holes and exit the granulator as granuled feed. In the granulator loose mixed fodder is moved into the mixer in which the mixture and nutrients, minerals, amino acids, oils and others are mixed, according to a specific recipe. After granulation the granules are cooled with a cooler. After going through all the processing steps on the granulator the finished mixed fodder has easy to store compact form. [12]

One of the problems of industry

It is necessary to reduce energy costs for granulation of animal feeds. In connection with this, recent attention has been paid to the methods of preconditioning and expansion of loose mixed fodder before granulation. A number of studies were carried out at the Department of Technology of Combined Feed and Biofuel ONAPT, and the following technological solution was proposed. The prepared loose animal feed passes through all the stages of standard preparation before the granulation process. Then part of the mixed fodder is granulated, and some are expended.

This makes it possible to obtain a part of the granulated and part of the expanded product. The effectiveness of this technology will be confirmed in the future, based on in-depth studies and obtained results. Based on the results of previous experiments, one can judge the positive effect of this technology, since the total energy consumption of the entire granulation line as a whole decreases. [13]

Conclusions on work

According to a preliminary literary review, It should be concluded that improving the technology of the granulation process for feed production is a topical issue in the feed industry today. The development of technology for improving the granulation process, by obtaining a separate expanded product (coarse expander, followed by grits) in the granulation line, will not only improve nutritious and sanitary quality of mixed fodder products, but also increase their productive effect. And the main advantage is the reduction of energy costs. [11, 12]

Today, more than ever, granulation is an important step in the total agricultural production process. With the advances in production of animal feeds technology, reductions in energy consumption, and increasing automation available there are many cost-effective solutions to reduce energy costs to provide quality production of animal feeds.

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ЗАСТОСУВАННЯ ТЕХНОЛОГІЇ ГРАНУЛЮВАННЯ У РІЗНИХ ГАЛУЗЯХ ПРОМИСЛОВОСТІ

Анотація

Наука і практика довели високу ефективність гранульованих продуктів. У цій статті представлений огляд технологій гранулювання для різних галузей промисловості. Процеси гранулювання - це масові технологічні процеси, які використовуються в даний час в широкому спектрі галузей: кормова промисловість, харчова промисловість, фармацевтична промисловість, виробництво добрив, поліетилен, виробництво металів, видобуток корисних копалин і інше. Широкий спектр різних матеріалів гранулюється, включаючи хімікати, залізну руду, комбікорм і багато іншого. Грануляція являє собою процес пресування або формування матеріалу у вигляді гранул.

Грануляція широко використовується у виробництві пігментів, барвників, синтетичних миючих засобів, каталізаторів, пластмас, сажі, хімічних реактивів і т. д. Використання гранульованої сировини в металургійній промисловості допомагає не тільки механізувати процеси, але і збільшувати їх інтенсивність за раху-

нок збільшуючи контактної поверхні взаємодіючих середовищ. Гранульовані добрива зберігають свої властивості протягом тривалого часу. У гірській промисловості процеси гранулювання використовуються на стадії підготовки і збагачення сировини і випуску готової продукції.

Особлива увага приділяється комбікормової промисловості. Грануляція дозволяє забезпечити стабільну однорідність, поліпшити санітарно-гігієнічні параметри, збільшити поживну цінність, збільшити термін зберігання, поліпшити фізичні властивості. Однак, незважаючи на всі переваги, існуючі лінії гранулювання мають відносно високу продуктивність і, в той же час, високі енерговитрати. У зв'язку з цим в цій статті пропонується технологія поліпшення гранулювання комбікормів. Згідно з попередніми літературними оглядам, слід зробити висновок, що вдосконалення технології процесу гранулювання для виробництва комбікормів є актуальною проблемою в кормовій промисловості сьогодні. Розробка технології по удосконаленню процесу гранулювання шляхом отримання окремого розширеного продукту (експандату) на лінії гранулювання не тільки поліпшить поживну і санітарну якість комбікормів, а також підвищить їх продуктивний ефект. І головною перевагою є зниження енерговитрат. Але ефективність цієї технології буде підтверджена в майбутньому на основі поглиблених досліджень і отриманих результатів.

Ключові слова: *технологія гранулювання, фармацевтична промисловість, виробництво полімерів і поліпропілену, виробництво біопалива, виробництво добрив, хімічна промисловість, виробництво металу, кормова промисловість, зниження споживання енергії, комбікорм.*

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«МОБІКАН» - БІЛКОВО-ВІТАМІННО-МІНЕРАЛЬНА ДОБАВКА ДЛЯ ДОМАШНІХ ТВАРИН

Анотація

В матеріалах статті наведені проблеми прояву дисплазії у домашніх тварин (собак) та шляхи її усунення за допомогою введення в раціон білково-вітамінно-мінеральних добавок. Представлені наукові та практичні результати розробки ТУ У 10.9-2574413678-001:2017 Білково-вітамінно-мінеральна добавка для собак "Мобікан".

На основі норм годівлі, хімічних властивостей кормової сировини, біологічних та зоотехнічних досліджень науково-обґрунтовані склад та рецептура білково-вітамінно-мінеральної добавки (БВМД) для собак. БВМД для собак "Мобікан" виготовляють згідно затверджених рецептур шляхом дозування та змішування попередньо очищеної і підготовленої білкової сировини тваринного і рослинного походження, мінеральної сировини, пробіотику, премікса і фітобіотиків (сухих екстрактів рослин).

Надано опис та принципову блок-схему виробництва БВМД для собак. Технологічна схема виробництва БВМД для собак включає наступні операції: розтарювання та очистка всіх видів сировини; її подрібнення та гранулометрична підготовка; дозування підготовлених макро- і мікрокомпонентів;дозування і змішування попередньої суміші мікрокомпонен-