UDC 631.363.2

DESIGNS OF MODERN PELLET PRESSES

Komar A.S., engineer
Dmytro Motornyi Tavria State Agrotechnological University, Zaporizhzhia, Ukraine

According to the design, granulator presses can be with a flat matrix, with a round matrix, with two vertical rotating matrices, a hybrid of a granulator with a flat and round matrix. In granulators with a flat rotating horizontal matrix, the material is pressed through holes in it by pressing rollers and formed into granules. The main elements of the press are rollers fixed on the drive shaft and a flat matrix. Such granulators are small in size, have a simple design, so they are suitable for enterprises with a small volume of processing, as well as private households. The disadvantages of this equipment include the fact that at a certain peripheral speed, the material is carried away to the periphery of the matrix under the action of centrifugal forces and, as a result, an uneven load on its working surface. Due to the difference in the angular velocities of the rollers, uneven wear of the surface of the matrix and rollers occurs. It is very difficult to achieve the same gap between all the rollers and the matrix. If one bearing in a roller fails, all bearings on the roller head are usually replaced. Repairing a flat die granulator will cost more than a round die granulator [1-5].

In granulators with a rotating round vertical matrix, the material is pressed through the matrix holes by pressing rollers and formed into granules [6]. In this press design, each roller is individually raised to the matrix, providing the necessary clearance and thus the best quality of the resulting product, as well as uniform wear of the rollers and matrix. Presses of this design are the most common, they account for about 90% of the entire granulator market. Their disadvantage is a high peripheral speed and, as a result, sensitivity to moisture and fraction of the granulated material, as well as higher energy consumption.

Granulators with two vertical matrices rotating in opposite directions do not have rollers. The matrices are arranged so that their outer diameters overlap each other like a gear transmission. Such granulators have not found wide application due to high operating costs and operational difficulties. A hybrid of a granulator with a flat and round matrix has appeared on the market relatively recently. Such a pellet press 3000-200-10 is presented by the companies "LesInTech" and Dieffenbacher (Germany) [7,8]. The equipment combines the advantages of presses with a flat and ring matrix, while eliminating such disadvantages as uneven wear of the matrices and rollers, long replacement time, lack of visual control over the granulation process. The granulator is designed for high-capacity plants. This model consists of ten units. The pressing unit includes a feeder, a pressing roller and a common flat matrix with a given hole diameter. Granulators with a gear drive are the cheapest to operate. They do not have large friction losses, as in a belt drive or a worm gear pair. They have the lowest cost and consumption of lubricants. The efficiency of a single-stage gear transmission is 98%, V-belt - 96% and decreases during operation (wear of belts), the efficiency of a worm gear is 90% [9].

Granulators with V-belt and gear transmissions are equally common. The advantages of V-belt transmission are greater resistance to vibrations and overloads of the granulation chamber, which are absorbed by belts and shafts. In granulators with gear transmission, more loads are transferred to the electric motor. For the equipment to work well, the belts must be of European manufacture, which seriously affects its price. When installing cheap, lower-quality belts, the pulleys will change their profile, and even original belts will begin to wear out quickly. Granulator electronics use sensors to monitor belt slippage, but at pellet plants these sensors quickly become dirty due to poor labor organization and poor personnel training. The service life of a V-belt transmission is about 30 thousand hours, but belt replacement is inexpensive. The service life of a gear transmission is up to 10 years, but the cost of replacement is very noticeable and can be up to 50% of the cost of the granulator. The two above-mentioned design features are fundamental in the classification of granulator designs. The most critical and intensively wearing part of the granulator is the matrix.

There are many varieties. A high-quality matrix must combine high resistance to abrasion, breakage and corrosion, and ensure high throughput to achieve optimal performance. The diameter of flat matrices is 100-1250 mm, the thickness is 20-100 mm. The diameter of a round matrix reaches 1000 mm. Since the cost of matrices is high, enterprises pay great attention to their preservation and proper operation. Matrices are made of different materials. The main requirements for materials are high wear resistance and elasticity. Stainless steel matrices have good wear resistance. As a rule, 40X or HARDOX 500 and 20CRMN steel are used. The steel used must be wear-resistant and have a hardening of 45-60 units. according to the Rockwell hardness scale [4-8].

According to the manufacturing technology, there are hardened matrices made of stainless steel, which can be vacuum-melted or through-hardened, and carburized matrices made of alloy steel. Obtaining granules of the correct shape by continuously passing raw materials through perforated matrices in granulators is achieved due to the pressure of the rollers and the friction of the raw materials against the metal walls of the matrix holes. The longer these holes, the longer the effect of friction and the stronger the granules. There is a ratio between the diameter of the granules and the length of the matrix holes (pressing length), which results in the established strength of the granules. The larger the diameter of the granules, the thicker the matrix should be. The live cross-section of the holes in the matrix has a great influence on the productivity of the granulator - the smaller it is, the lower the productivity. Often, countersinks are made in the matrix holes to facilitate the entry of the product into the holes [9].

The thickness of the matrix should be 10 times greater than the diameter of the holes. When producing matrices less than 50.8 mm thick, counterboring of holes is used, which consists in boring the upper edges of the holes with a drill. Sometimes chamfers are made on the holes. Thus, matrices 50.8 mm thick can have holes measuring 4.8 x 38.1 mm with a conical recess of 12.7 mm. In this case, the effective length of granule formation is 38.1 mm. Holes for pressing granules with a diameter of 2.4 to 4.8 mm have a small countersink at the inlet. Holes for granules with a diameter of 9.5 mm and above are not only countersunk, but also processed to a cone up to half, and in some cases even more.

References.

1. Komar A. Features of biomass granulation. Перспективная техника и технологии в АПК: материалы Международной научной конференции студентов, магистрантов и аспирантов. Минск: БГАТУ, 2021. С. 125–127.
2. Болтянський Б. В. Конструктивно-технологічне вдосконалення вальцевих грануляторів з плоскою матрицею. Науковий вісник ТДАТУ. Запоріжжя: ТДАТУ, 2023. Вип. 13, том 1. №11. DOI: 10.31388/2220-8674-2023-1-11. URL: https://oj.tsatu.edu.ua/index.php/visnik/article/view/362.
3. Комар А. С., Болтянська Н. І. Аналіз способів ущільнення дрібних сипких матеріалів. Матеріали IV Міжнар. наук.-практ. конференції «Біоенергетичні системи» (28–29 травня 2020 р). Житомир: ПНУ, 2020. С. 6–10.
4. Болтянська Н. І. Визначення умови економічної доцільності підвищення надійності прес-гранулятора. Вісник ХНУСГ, «Проблеми надійності машин». 2019. Вип. 205. С. 398–405.
5. Болтянська Н.І., Комар А.С. Переробка пташиного посліду на добриво шляхом його гранулювання. Тези V Міжн. наук.-практ. конф. «Інноваційні технології вирощування, зберігання і переробки продукції садівництва та рослинництва”». Умань, 2019. С. 18–20.
6. Скляр О.Г., Скляр Р.В. Теоретичні аспекти вибору лінії гранулювання посліду перепелів. Технічне забезпечення інноваційних технологій в агропромисловому комплексі: матеріали V Міжнародної науково-практичної конференції (01–24 листопада 2023 року). Запоріжжя: ТДАТУ, 2023. С. 345–348.
7. Болтянська Н.І. Розробка конструкції преса-гранулятора для переробки пташиного посліду. Зб. наукових-праць Міжн. наук.-практ. конф. «Актуальні питання розвитку аграрної науки в Україні». Ніжин, 2019. С. 84–91.

8. Болтянська Н.І., Комар А.С. Аналіз конструкцій пресів для приготування кормових гранул та паливних брикетів. Науковий вісник ТДАТУ. 2018. Вип.8. Т.2. С. 44–56.

9. Болтянська Н.І. Напрями удосконалення робочого процесу вальцово- матричних прес-грануляторів. Сучасні наукові дослідження на шляху до євроінтеграції: мат. Міжн. наук.-практ. форуму. ТДАТУ. 2019. Ч. 1. С. 33–36.