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STUDY OF DESIGN PARAMETERS OF VIBRATING SIFTERS
ДОСЛІДЖЕННЯ КОНСТРУКТИВНИХ ПАРАМЕТРІВ ВІБРАЦІЙНИХ ПРОСІЮВАЧІВ

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Abstract. *The article deals with the problems of sieving bulk materials using air flow; the optimal size of sieve openings, as well as the fractional characteristics of sieved food bulk masses, which determine the technological efficiency and specific productivity of sieving machines. The aim of the article is to evaluate the mechanics of the vibration sieving process and determine the limits of the intensity of vibrations of the working surface with the development of new designs of vibratory flour sifters.*

Key words: *sieve, sieving, vibration, adhesion, vibrating surface.*

Анотація. *У статті розглядаються проблеми просіювання сипких матеріалів за допомогою повітряного потоку; оптимальний розмір отворів сит, а також фракційні характеристики просіювальних харчових сипких мас, від яких залежать технологічна ефективність і питома продуктивність просіювальних машин. Метою статті є оцінка механіки процесу вібраційного просіювання та визначення меж інтенсивності коливань робочої поверхні з розробкою нових конструкцій вібраційних просіювачів борошна.*

Ключові слова: *сито, просіювання, вібрація, адгезія, вібруюча поверхня.*

Introduction.

To separate bulk products into fractions by particle size, machines are used that use a system of moving sieves or airflow as their working body. These machines are used to remove impurities from flour at bakeries, confectioneries, and pasta factories [4-8].

The main methods of sieving include: sieve, pneumatic and vibratory sieving.

The main disadvantage of sieve sieving is that its resolution and specific productivity decrease with a decrease in the maximum particle size due to clogging of the sieve meshes by a highly dispersed bulk product.

Pneumatic sieving, which is carried out in an air stream, has become widely used in the production of lightly dispersed powders. However, this method has not found practical use for sifting flour [1-3].

Main text.

The present work is devoted to the study of sieving during the movement of bulk products by inclined vertically vibrating surfaces, as well as to the analysis of methods for its implementation.

The most important advantages of vibratory sieving include high specific productivity and low energy consumption with a fairly high sieving efficiency. The method of vibratory sieving of coarse-grained bulk materials is based on the movement in different directions of unrelated rather heavy particles by the sieving surface of a deck that oscillates at an acute angle to the horizon. The technological efficiency of separation and the resolution of the vibrating screening process is inversely related to the specific loading of the screening surface of the deck. This circumstance hinders the further development and implementation of the vibratory sieving method in production [4–6].

Vibratory sieving has the following advantages: - high productivity and efficiency of the process of sifting bulk products; - the entire process takes place in one device; - the ability to directly observe the sifting process; - absence of dust and particle removal; - simplicity of design; - the ability to change the specified modes of vibration without changing the vibration parameters of the deck.

Improving and developing rational designs of bulk material sifters and increasing their efficiency is one of the main tasks of the food industry. In view of the above, vibration sieving is promising, as it provides a significant intensification of the process and reduces specific energy consumption.

The purpose of studying the vibration sieving process is to determine the movement of bulk products by inclined vibrating surfaces with the development of new designs of flour sieves [7,8,10].

To achieve this goal, a number of interrelated scientific tasks were solved, namely: the mechanics of the vibration sieving process were investigated and established; the limits of the interval of the intensity of vibrations of the sieving surface were established; theoretical dependences of the parameters of vibration movement of the layer of flour particles on the parameters of deck vibrations were obtained; a design scheme of a vibratory flour sifter was proposed [9,11].

As a result of the research, a new simplified design of a vibratory sifter using a crank mechanism was developed to reduce energy consumption (Figure 1).

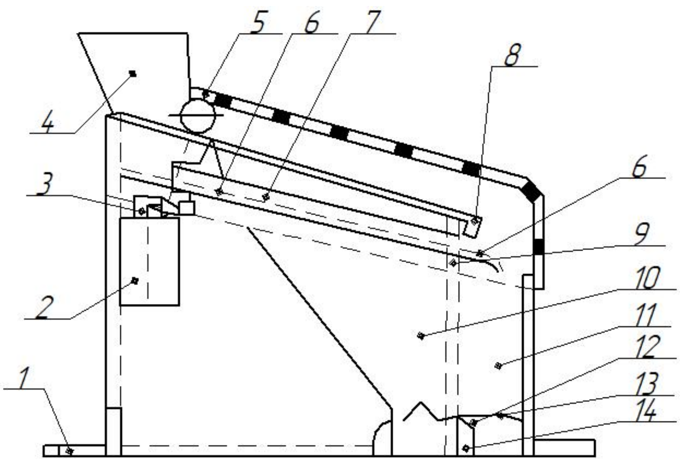

Figure 1 – Vibrating sifter:
1 – frame; 2 – electric motor; 3 – crank mechanism;
4 – loading hopper; 5 – cover; 6, 9 – spring supports; 7 – punching sieve; 8 – sieve frame; 10, 11 – flour collector with discharge pipe; 12 – pipe; 13 – magnetic catcher; 14 – hinged tray.

The vibrating sifter consists of a frame 1, a loading hopper 4, a wooden sieve frame 8 measuring 370x500 mm with a punching sieve 7 with ø1.5 mm holes installed. The wooden frame with the sieve can be installed not only horizontally, but also at a certain angle using the adjusting screws. The frame is suspended from the end sides to the bracket by means of wooden spring supports 6, 9, which significantly reduces the resistance to material flow and makes it possible to use the drive energy more efficiently and improve the sieving process. The top of the frame with the sieve is covered with a plexiglass cover 5; a crank mechanism 3 is attached to the middle of the end side of the wooden frame, driven by an electric motor 2 mounted on the frame. The sifter also includes a collection of sifted flour with a discharge nozzle 11 equipped with a magnetic catcher 13, a pipe 12 and a hinged tray 14.

This design allows for more efficient use of drive energy, and with the sieve tilted, the lower layer of flour is more efficiently moved through, improving the process.

The sieve capacity is characterized by three variables:

1) the amount of product entering the sieve P, kg/s
2) the amount of descent Pe, kg/s
3) the number of passes Pp, kg/s. [7,8].

If the initial ordinate of the passage distribution curve dP/dx is denoted as B_0, then any subsequent ordinate at a distance x from the sieve head will be determined from the equation:

$$y = \frac{dP}{dx} = B_0 e^{-\mu x} \quad (1)$$

where $B_0 = \frac{dP}{dx}$ at x = 0, and the coefficient μ characterizes the material being processed and the sieve. To determine the passage, it is necessary to integrate the curve dP/dx , i.e.

$$\Pi = \int_0^x y dx = \int_0^x B_0 e^{-\mu x} = \frac{B_0}{\mu}(1 - e^{-\mu x}) \quad (2)$$

The given sieve capacity, divided into 10 parts, shows that the first half of the sieve sows 74.7% of the total passage, and the second half - 25.3%.

Conclusions.

The efficiency of sieving bulk materials is determined by the ratio of the productivity to the energy consumption of the respective devices. Productivity and energy consumption to some extent depend on the resistance to material flow provided by the design of the working chamber or transportation systems. The specific productivity of a sieve by passage is proportional to the number of particles that have passed over the sieve opening in 1 s with the probability of their sifting.

Based on the results obtained, it can be argued that the design of a vibrating sifter can significantly reduce the resistance to material flow, more rationally use the drive energy, and increase the efficiency of sifting bulk materials.

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