



IDENTIFICATION OF SIGNIFICANT FACTORS IN THE PROCESS OF GRAIN MIXTURES SEPARATION ON CYLINDRICAL SIEVE

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Abstract

The efficiency of post-harvest processing of grain mixtures determines the quality and safety of food grain and seed material. Drum separators with cylindrical sieves are common machines used for pre-cleaning of grain heaps with high humidity and clogging. The problem with the use of drum separators with horizontally located cylindrical sieves is their insufficient productivity due to the low contact area of the grain material with the surface of the sieve. The analysis of design features of this type of machines has been carried out in the work, the results of researches of increase of efficiency of work of drum separators have been determined.

The analysis allowed to discover ways of increasing the efficiency of the process of cleaning grain materials on cylindrical sieves which have been brought to a common classification.

It has been established that changing the location of elongated holes relative to the axis of rotation is a promising way to improve the design of the sieves. For further research in this area, the parameters of the process of cleaning grain mixtures are identified, which are significant and affect the technological efficiency.

Key words: identification, sieve, holes, location, screening, efficiency.

RESEARCH ANALYSIS

Postharvest processing is one of the important operations in the production of grain or seeds. Processing includes purification, drying and calibration into fractions. The operation is carried out in a short agricultural period, mainly under significant humidity and clogging of grain material.

The main working bodies of grain cleaning machines and separators are sieves and pneumatic separation channels. The separation of the components of the grain mixture is carried out by size and aerodynamic characteristics.

Operating devices determine the efficiency of technological processes of grain cleaning machines, as well as their productivity and quality of work.

The use of sieves in the form of rotating surfaces and giving them rotational motion is a promising direction in terms of improving the efficiency of the screening process. Due to the additional action of centrifugal force on the grain mixture, the sievability of components through the holes of such sieves is much higher compared to flat ones. Cylindrical, conical, paraboloid and other types of sieve surfaces became widespread which can be horizontal, inclined and vertical depending on their location.

Under the conditions mentioned above, the use of grain cleaning machines with cylindrical sieves, which are located horizontally (Fig.1), as practice has shown, is more efficient.

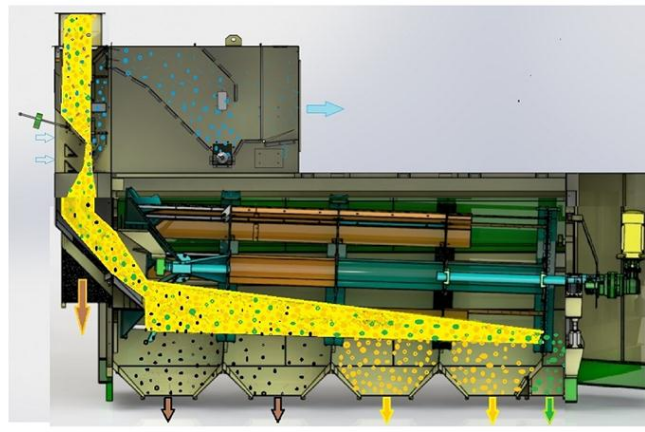


Figure 1. The scheme of operation of the grain cleaning separator MAROT

Despite the high indicators of productivity and quality of work on clogged and wet grain mixtures, their specific productivity per unit area of the sieve is inferior to the indicators of flat-sieve grain cleaning machines. This is due to the fact that the effective screening area on the sieves varies from 20 to 40%, depending on the design and kinematic parameters.

Thus, the analysis of methods and structures that increase the efficiency of the process of cleaning grain mixtures requires more detailed research.

THE AIM OF THE WORK

The aim of the work is to establish a classification of ways to increase the efficiency of the process of cleaning grain mixtures on cylindrical sieves, to determine the prospects and to identify significant factors.

RESULTS AND DISCUSSION

For active sieving through the holes of a cylindrical sieve, which performs circular oscillations in the plane of its rotation, the mobility of particles in the plane of the sieve must be at the lowest relative speed and with the greatest force of normal pressure.

The operation of horizontal vibration-centrifugal gratings that perform spatial oscillations was studied in (Mazorenko 2003). The sifting of fine particles occurs under the influence of the radial component of the amplitude of oscillations, and the movement of grain mixtures – under the influence of the axial component. The specific productivity of sieves on the separation of rice grain mixtures was $32 \text{ kg} / \text{dm}^2 \cdot \text{h}$ with a completeness of separation of $\mathcal{E}_p = 0,95$.

The substantiation of the parameters of conical sieves was carried out by N.Ye. Avdeiev in (Avdeiev 1987). The author determined an increase in productivity by several times compared to flat sieves.

In (Goncharov 1986) carried out a mechanical and technological substantiation and developed universal vibration-centrifugal separators. The specific productivity of the screening process with cylindrical

sieves is the highest with a vertical axis of rotation. The specific productivity of vibration-centrifugal cylindrical sieves is 3... 5 times as high as that of flat ones, with the same separation quality. The author sets the optimal kinematic parameters of cylindrical vibrating screens.

In (Tishchenko *et. al* 2008) the results of the study of increasing the separation of grain mixtures on cylindrical scaly surfaces due to air flow purge are presented.

In (Tishchenko 2004) presented an analysis of the results of research on the indicators of separation of grain mixtures by flat oscillating, vibrating and vibrocentric sieves with different nature of their oscillations and at optimal kinematic modes of their operation. The author sets the range of changes in the values of integral parameters: acceleration and velocity. It is obvious that the mathematical modeling of the screening process by structural sieves adopted by the authors did not take into account or simplified some significant phenomena, which requires further refinement and development.

Having analyzed the research of the process of sifting grain mixtures, the lack of a clear classification of factors that affect the productivity and quality of this process was revealed. This is explained by the fact that only certain stages of the processes of separation of the grain mixture are taken into account: segregation (Tishchenko *et. al* 2007; Piven 2006) or sifting of particles through the holes of the sieve (Mironov 1985); the quality of experimental studies of physical processes; the use of insufficiently accurate and advanced methods of studying the physical and mathematical properties of grain mixtures.

Among the conditions for effective sieving of grain mixtures on sieves, the researchers (Tishchenko *et. al* 2007; Piven 2006; Mironov 1985; Zavgorodniy A.I. 1992) distinguish: specific load, kinematic parameters of the sieve (speed, amplitude and frequency of oscillations), design parameters (sieve dimensions, size and shape of holes, partitions, etc.), type and particle size distribution of the mixture, the presence of effective cleaners, the duration of the process, etc.

One of the disadvantages of common drum separators is the lack of efficiency with sieves that have

longitudinal holes and divide the grain mixture by the thickness of the component.

The technological process of the drum separator involves the supply and movement of grain material inside the sieve and sifting the components through the holes on the outside (Fig.2). Basic sieves for existing drum separators have holes along the axis of the drum rotor. This arrangement does not coincide with the main motion of the grain mixture inside the sieve drum.

The motion of the grain mixture in the cylindrical sieve takes place with the circulation (Fig.2). However, the modes of motion of the grain mixture depend on a number of parameters: the speed of rotation of the drum, its diameter, the presence of structural elements inside the drum. So to increase the area of the sieving surface, set the blades or partitions (Fig.3). With the help of blades, the grain mixture has more time to come into contact with the sieve, which increases the sieving and productivity of the separator.

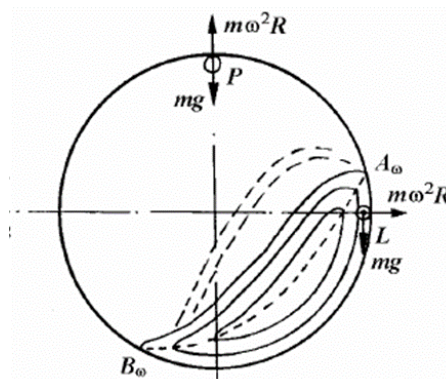


Figure 2. Schemes of the motion of grain in sieve drums

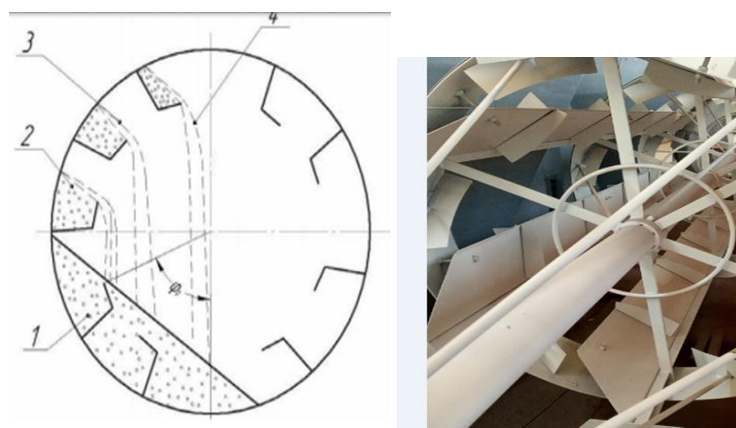


Figure 3. Installation of additional elements – blades

The frequency of rotation and the radius of the sieve are taken into account using the centrifugal coefficient K , which is determined by the expression:

$$K = \omega^2 R / g, \quad (1)$$

where ω – frequency of rotation of the drum, rpm; R – radius of the sieve, m.

The numerical value of the centrifugal coefficient determines the mode of motion of the grain mixture in a cylindrical sieve. The following modes are defined in (Patrin 2015): shuttle, rolling, mixed, portion, waterfall and tubular.

The influence of forces on the particle of the grain mixture at the coefficient $K = 1.5$ and the tubular mode (the mixture moves in an annular layer) (Patrin 2015). Assumes that the working surface of the sieve is filled completely. Then, the effective area of the sieving surface is 100%.

From the point of view of the maximum sieving of particles of the passage fraction, this effect (tubular mode) turned out to be the most recommended. However, the productivity of the sieve consists of the sum of tailing and screening productivity. Moreover, tailing productivity is determined by the speed of grain material along the axis OO_1 of the cylindrical sieve (Fig.4) (Chursinov, Filipenko 2015).

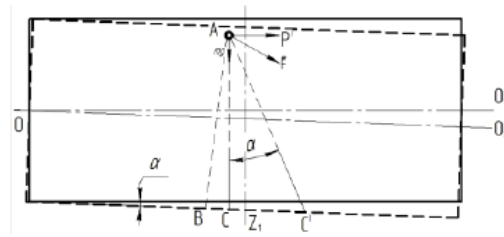


Figure 4. The scheme of the motion of grain material along the axis

When using a tubular (circular) mode with a coefficient of centrifugation of 1 and above, the motion of the mixture along the axis will be difficult due to the influence of centrifugal forces. A small angle of inclination of the axis OO_1-OO_2 (Fig.4) relative to the horizon should be noted, which cannot ensure the motion of the grain mixture along the axis.

The use of modes with low coefficients of centrifugation, on the contrary, leads to the intensity of the mixture along the axis of the OO . Particles of the grain mixture when poured from the upper sectors of the sieve (point A, Fig.4) are lowered to the lower zone at an angle α , thus, providing the motion CC^1 .

Obviously, the presence of a compromise solution will ensure maximum sifting of the grain mixture (which is typical for significant coefficients of centrifugation and increased speed) and its movement along the axis.

Taking into account the analysis carried out, the results can be systematized in the form of the following classification of ways to increase the efficiency of the process of cleaning grain and seed mixtures (Fig.5).

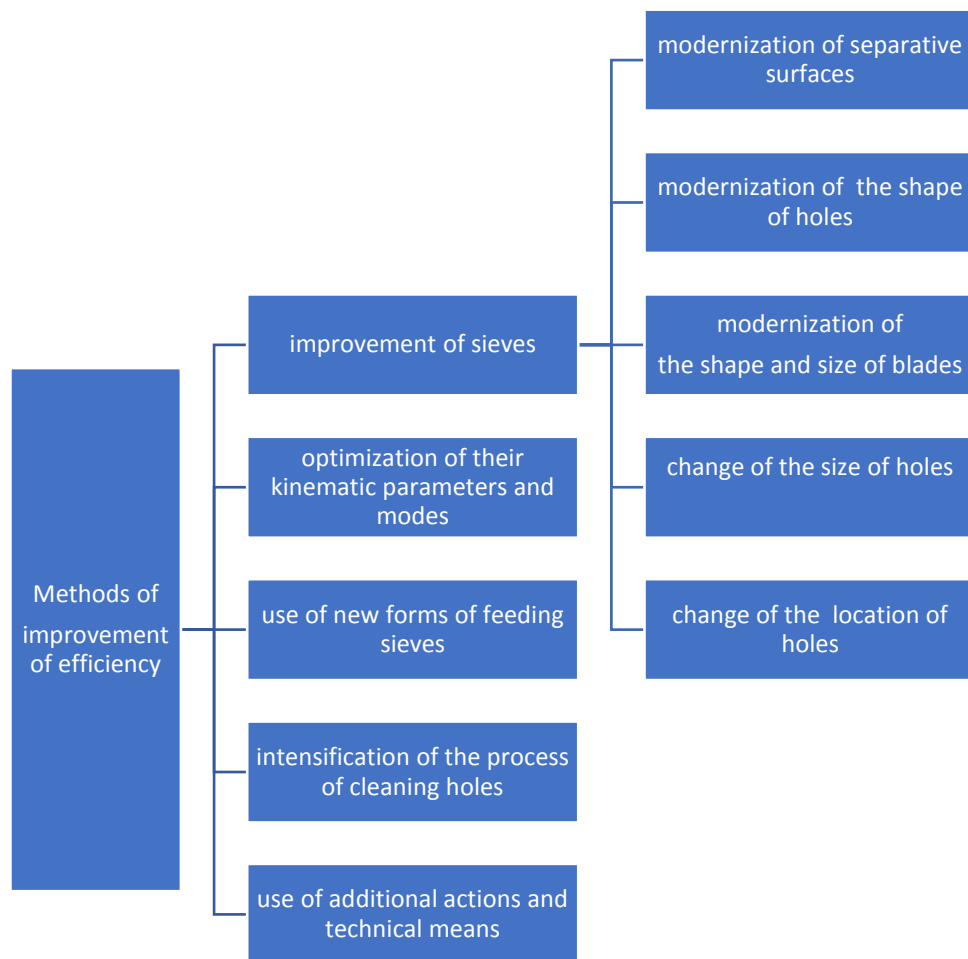


Figure 5. Classification of ways to increase the efficiency of the process of cleaning grain mixtures on

cylindrical sieves

Based on the analysis carried out, the main ways to increase the efficiency of the process of cleaning grain mixtures with cylindrical sieves are as follows: improving the design of sieves; optimization of their kinematic parameters and modes; use of new forms of feeding sieves; intensification of the process of cleaning holes; use of additional actions and technical means.

CONCLUSIONS

Thus, a conclusion can be made that the most promising way to increase the efficiency of the process of cleaning grain mixtures, which does not cause changes in the design and kinematics of the working body of the grain cleaning separator, is to improve the sieves by changing the location of the holes.

The study of the efficiency of the cylindrical sieve with the following parameters that vary is of a great scientific value: in particular the location of the longitudinal holes relative to the axis of its rotation; sieve rotation speed; and sieve angle. In addition, it is necessary to conduct research on grain mixtures of different crops with various properties.

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