METHODS OF APPLICATION OF VIBRATION TECHNOLOGIES IN AGRICULTURAL MACHINERY

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Abstract . *This in the article village farm in their cars vibration technologies application their methods constructive And technological functions and efficiency effect analysis done vibration influence through to the ground processing to give , to give landing And resource thrift security problems seeing developed studies results based on optimal parameters choice in accordance with recommendations given .*

Key words : *vibration , vibration , village farm cars , workers organ , amplitude , frequency , gravity resistance .*

Modernization of the agricultural sector, mechanization of production processes and the introduction of energy-saving technologies are among the most pressing challenges of our time. Especially in places. processing give , plant , fertilize And harvest collecting take in processes high to efficiency achieve For modern technician And technological solutions application demand This is being done.

In recent years, interest in the use of vibration technologies in agricultural machinery has grown. This is due to the positive impact of mechanical vibrations on technological processes, specifically by improving the interaction of working bodies with the soil, reducing traction resistance, and improving tillage quality. Research has shown that vibration facilitates the breakdown of soil layers, improves the penetration of working bodies into the soil, and reduces energy consumption [1-3].

At the same time, vibration technologies are effectively used in agriculture not only for soil cultivation but also for seeding, sorting, and processing. The use of vibrating working tools increases labor productivity, reduces fuel consumption, and improves processing quality.

However, the design solutions for existing vibration machines and mechanisms, the optimal selection of their parameters, and the determination of vibration frequency and amplitude remain unresolved. Effective vibration control, especially considering the physical and mechanical properties of the soil, remains a pressing scientific challenge.

There are also many different designs of vibration generating mechanisms, and their efficiency largely depends on the type of vibration drive used and its kinematic and dynamic parameters. This creates a need to develop new, energy-efficient , and highly effective vibration mechanisms.

Based on the above, increasing the efficiency of the use of vibration technologies in agricultural machinery, improving its design and mode parameters, as well as their practical implementation are considered to be of great scientific and practical significance.

Mechanization and automation of agricultural production processes are among the most important challenges of our time. Of particular importance are, in particular, increasing labor efficiency, reducing energy consumption, and improving product quality through the development and implementation of resource-efficient technologies.

In recent years, vibration technologies have become widespread in agricultural machinery. Vibration is a repetitive motion in a mechanical system over time that affects the working environment (soil, seeds, fertilizers, etc.) through the working bodies. Vibration intensifies work processes and increases the efficiency of interaction between the working bodies and the environment [4].

Scientific research shows that the use of vibration technologies: significantly reduces traction resistance during soil cultivation; Facilitates working conditions for workers; reduces fuel consumption; increases productivity.

In particular, the use of vibration during soil cultivation improves the loosening of soil layers, increases agronomic performance, and improves the quality of work.

At the same time, it's important to correctly select vibration mechanisms and optimize their parameters. Incorrectly selected frequency or amplitude can reduce operating efficiency or lead to technical malfunctions.

The implementation of vibration technologies in agricultural machinery depends largely on the design, kinematics, and dynamic characteristics of the vibration mechanisms used. To this end, this study systematically analyzed the types of vibration mechanisms commonly used in practice and scientifically substantiated their operating principles, advantages, and disadvantages [5].

Spring mechanisms are one of the most common designs in agricultural machinery. They attach the working parts to the frame using elastic elements.

The key feature of these mechanisms is that their vibrations occur naturally, without external force. This ensures a simple design and energy efficiency .

The frequency of oscillations in spring mechanisms depends on the following factors: Spring stiffness (k), mass of working fluid (m), external resistance.

Theoretically, their specific frequency is determined by the following expression:

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

Advantages: Simplicity design; reliability and long service life; low energy consumption. Disadvantages : limited ability to accurately control vibration parameters; Variability of parameters during operation; difficulty in constantly maintaining optimal conditions [6].

Unbalanced vibrators are one of the most effective methods for generating mechanical vibrations. Their operating principle is based on the creation of centrifugal force under the influence of a rotating unbalanced mass.

If the unbalanced mass is m, the radius of eccentricity is r, and the angular velocity is ω, then the resulting oscillation force is expressed as follows:

$$F = m \cdot r \cdot \omega^2$$

These mechanisms have a high probability of controlling vibration parameters: Frequency is determined by the rotation speed; amplitude is determined by the mass and radius. Advantages: Ability to generate high dynamic force; ability to precisely control vibration parameters; adaptability to various operating conditions. Disadvantages : Dynamic loads are high; the impact on structural elements is strong; faster wear of bearings and shafts [2, 7].

Planetary vibration mechanisms have a complex kinematic design in which vibrational motion is generated by central and auxiliary gears. In these mechanisms, the inertial elements (satellites) perform both rotational and translational motion simultaneously.

The main advantage of planetary mechanisms is the ability to precisely control the oscillatory motion and change its trajectory. This optimizes the impact on the workpiece.

Advantages: Highly accurate vibration parameters; ability to create asymmetric and directional vibrations; high efficiency. Disadvantages: Complex design; high production costs; high maintenance requirements.

Parallelogram mechanisms are used to ensure the stability of the workpiece's trajectory. In these mechanisms, the workpiece moves parallel to the machine using special hinge joints, allowing the machining depth to be maintained [4, 5].

These mechanisms are often used in combination with vibrating working bodies, stabilizing their movement. Advantages: consistent tillage depth; precise working body movement; improved agronomic performance. Disadvantages: additional structural components; increased weight and dimensions; difficult maintenance.

The results of theoretical and experimental studies confirmed the high efficiency of vibration technologies in agricultural machinery. The results were comprehensively analyzed, and the impact of vibration parameters on technological processes was determined.

Research has shown that vibration of the working fluid disrupts the internal structure of the soil and reduces its resistance. This facilitates the movement of the working fluid and reduces overall traction resistance.

According to the results of the experiment: Traction resistance is reduced by 30–50% ; energy consumption is reduced by 20–35% ; and unit operating stability is increased . This is explained by the following physical processes: vibration reduces the cohesive forces between soil particles; the coefficient of internal friction decreases; and the soil approaches a state of "liquefaction."

It has been established that the vibration effect has a positive impact on soil structure. Specifically, the degree of soil fineness increases; aggregate coatings become uniform; the capillary structure is maintained; and moisture retention capacity is improved.

Studies have shown that vibration reduces the size of soil aggregates by 15–25%. This ensures that seeds settle and germinate at a uniform depth [4, 6].

The study analyzed the effect of the main vibration parameters—frequency and amplitude—on the work process.

It was found that efficiency directly depends on the following parameters: When the frequency exceeds 30 Hz: An increase in dynamic loads is observed; the aging of the working body accelerates; efficiency begins to decrease.

As a result of research into vibratory planters: Uniformity of seed distribution improved by 20-25 % ; Planting accuracy increased ; mechanical damage to seeds reduced;

These results are explained by the fact that the seed's movement characteristics change under the influence of vibration. That is, they transition to a " quasi-liquid " state and begin to move freely [3].

The use of vibration mechanisms improves working conditions for workers. As a result: The service life of the working parts increased by 2-3 times ; the probability of failure upon collision with obstacles decreased; a self-cleaning effect was observed. This is due to the fact that soil and plant residue do not adhere to the working part under the influence of vibration.

The results obtained demonstrated that the use of vibration technologies in agriculture is highly economically and technologically efficient. Vibration not only intensifies the work process but also improves the reliability of machine components.

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