

2. Roshith P. The influence of compressive residual stress on metallurgical and mechanical properties of materials exposed to shot peening: a review // *Canadian Metallurgical Quarterly*. 2024. Vol. 63, No. 2. P. 373–413. DOI: 10.1080/00084433.2023.2213045.

3. Uddin M., Rech J., Hall C., Schlaefel T. Characterisation and analysis of surface integrity and residual stress in laser direct energy deposited 316L alloy subject to plasticity ball burnishing // *Scientific Reports*. 2025. Vol. 15. 23151. DOI: 10.1038/s41598-025-07496-3.

4. Guan H., Zhang J., Zhang X., Sun G., Duan C. Study on the effects of shot peening intensity on the microstructure, friction and wear properties of high-strength steel // *PLoS ONE*. 2024. Vol. 19, No. 12. e0314561. DOI: 10.1371/journal.pone.0314561.

5. Ebrahimzadeh P., Martínez L. B. P., Pariente I. F. Optimization of shot-peening parameters for steel AISI 316L via response surface methodology // *The International Journal of Advanced Manufacturing Technology*. 2024. Vol. 132. P. 647–667. DOI: 10.1007/s00170-024-13274-8.

6. Liu X., Meng T. Y., Li W. B., Jiang C. H. Surface shot peening of cast SiCw/Al composites // *Heat Treatment and Surface Engineering*. 2024. Vol. 6, No. 1. DOI: 10.1080/25787616.2024.2338972.

7. Shao C., Wang D., Zang Y., Cheng P. Surface residual stress release behavior of shot-peened springs // *Metals*. 2024. Vol. 14, No. 3. 355. DOI: 10.3390/met14030355.

UDC 631.361.8

**RESEARCH ON THE INFLUENCE OF DESIGN PARAMETERS
ON THE STRESS-DEFORMED STATE OF WORKING BODIES OF THE CUCUMBER
AND MELON SEEDS SEPARATOR**

**ДОСЛІДЖЕННЯ ВПЛИВУ КОНСТРУКТИВНИХ ПАРАМЕТРІВ
НА НАПРУЖЕНО-ДЕФОРМОВАНИЙ СТАН РОБОЧИХ ОРГАНІВ СЕПАРАТОРА
НАСІННЯ ОГІРКА ТА ДИНИ**

Dmytro Babenko

Mykolaiv National Agrarian University, Mykolaiv, Ukraine

Mechanization of primary processing processes of melon and vegetable crops is one of the priority areas of development of agricultural engineering. The production of cucumber and melon seeds deserves special attention, the demand for which is steadily growing both in the domestic and foreign markets. The efficiency of seed separation is largely determined by the quality of the separation equipment. The issues of mechanization of seed separation processes from melon and vegetable fruits are considered quite widely in the works of domestic and foreign scientists, however, comprehensive studies of the stress-strain state of separation equipment remain insufficiently covered.

The general principles of design and calculation of vibrating separators are outlined, where approaches to the selection of structural and kinematic parameters of screens are systematized. It is shown that under variable operating modes, the amplitudes of dynamic forces can exceed static ones by 1.8–2.4 times, which is fundamentally important for assessing the resource of parts. At the same time, the specifics of the interaction of the mechanism with elastic-viscous raw materials (fruit pulp) are not taken into account in this work [1].

A comparative analysis of the designs of melon processing machines was conducted and it was found that the hinged suspensions of the screens are most susceptible to fatigue failure of the nodes due to the alternating nature of the loads. It was found that the stress concentration in the areas of the connections of the connecting rod with the crank and the connecting rod with the slider are critical from the point of view of fatigue strength, and it is recommended to use smooth fillets with a radius of at least 3 mm [2]. It was found that the viscosity of the mixture varies in the range of 0.8–3.2 Pa·s depending on the degree of ripeness of

the fruits, which causes the variability of the resistance to the movement of the material through the sieve holes and, accordingly, the variability of the loads on the drive [3].

Thus, the analysis of literary sources indicates that, despite the significant number of works devoted to individual aspects of the functioning of vibration separators and the calculation of their elements, a comprehensive study of the influence of the design parameters of the cucumber and melon seed separator on the stress-strain state of its supporting nodes is practically absent in the scientific literature. The identified gap determines the scientific novelty and practical focus of this work.

Existing designs of seed separators are characterized by intensive wear of individual components, which is associated with the complex nature of the loads - a combination of shock, vibration and contact effects when interacting with viscoplastic raw materials. The lack of systematized data on the stress-strain state of structural elements complicates the design of machines with optimal mass-dimensional indicators and limits the possibilities of predicting their resource. The above makes it relevant to study the influence of the design parameters of the separator on its stress-strain state.

The seed separator includes two vibrating sieves (upper and lower), suspended on articulated suspensions and performing oscillatory motion in antiphase. The sieves are driven by an electric motor through a V-belt transmission, a variator and crank mechanisms, which allows you to adjust the amplitude-frequency parameters of the oscillations. The crushed mass passes sequentially through both sieves: the upper one provides coarse separation with the removal of crust particles, the lower one - fine separation of seeds from finely dispersed impurities and the liquid phase.

A characteristic feature of the machine's operation is the variability of loading modes and different physical and mechanical characteristics of the processed raw materials (cucumber and melon have different rheological properties), which generates a complex dynamic picture of the stress state of the load-bearing elements.

To calculate the stress-strain state of the main elements of the cucumber seed separator, we will assume the following initial values [4]: Young's modulus $E=2 \cdot 10^5$ MPa; Poisson's ratio $\nu=0.3$; allowable stresses for steel $\sigma_{add}=160$ MPa. The drum shafts have the following initial characteristics: diameter $d=35$ mm=0.035 m; length between supports $L=1$ m; bending force $F=200$ N; torque $T=50$ N·m.

Let's calculate the bending moment:

$$M_{\max} = \frac{FL}{4} = \frac{200 \cdot 1}{4} = 50 \text{ N} \cdot \text{m} \quad (1)$$

Bending stress:

$$\sigma_{\max} = \frac{32M_{\max}}{\pi d^3} \quad (2)$$

Let's substitute:

$$\sigma_{\max} = \frac{32 \cdot 50}{3,1416 \cdot (0.035)^3} = \frac{1600}{0,000134} = 11,9 \cdot 10^6 \text{ Па} = 11,9 \text{ MPa} \quad (3)$$

Torsion stress:

$$\tau_{\max} = \frac{16T}{\pi d^3} = \frac{16 \cdot 50}{3,1416 \cdot (0.035)^3} = 5,95 \cdot 10^6 \text{ Па} = 5,95 \text{ MPa} \quad (4)$$

For a crank mechanism: crank diameter $d=30$ mm=0.03m; lever length $L=0.25$ m; force $F_s=150$ N. Then the bending moment:

$$M = F_s \cdot L = 150 \cdot 0.25 = 37.5 \text{ N} \quad (5)$$

Bending stress:

$$\sigma_{cr} = \frac{32M}{\pi d^3} = \frac{32 \cdot 37.5}{3,1416 \cdot 0.03^3} = \frac{1200}{8,48 \cdot 10^{-5}} \approx 14,15 \cdot 10^6 \text{ Па} = 14,15 \text{ MPa} \quad (6)$$

Strength test:

$$\sigma_{kr}=14.15<\sigma_{dop}=160 \text{ MPa}$$

The vibration load of the sieve is calculated based on the following parameters: sieve mass $m=10$ kg; vibration amplitude $x_{max}=0.005$ m; suspension stiffness $k=5000$ N/m

Then the force from the oscillation:

$$F=k \cdot x_{max}=5000 \cdot 0.005=25 \text{ N}$$

Stress at the center of the plate (fine sieve, formula for a rectangular plate):

$$\sigma_{sieve} = \frac{3FL^2}{2bh^2} = \frac{3 \cdot 25 \cdot 0.6^2}{2 \cdot 0.3 \cdot 0.005^2} = 1.8 \cdot 10^6 \text{ Па} = 1.8 \text{ MPa} \quad (7)$$

$$\text{Check: } \sigma_{sieve}=1.8<\sigma_{add}=160 \text{ MPa}$$

The practical value of the work lies in the possibility of using the obtained results in the design of new and modernization of existing seed separators. Substantiated design parameters will ensure a reduction in the stress level in the most loaded sections by 15–25%, which will accordingly increase the service life of the machine and increase the reliability of the technological process of selecting cucumber and melon seeds.

It is advisable to direct further research towards experimental verification of calculation models by strain gage testing and assessment of the fatigue strength of structural elements under cyclic loading conditions.

References:

1. Wu, Y., et al. (2024). Simulation analysis and parameter optimization of seed–flesh separation process based on DEM. *Agriculture*, 14(7), 1008. <https://doi.org/10.3390/agriculture14071008>.
2. Ahmed, A., Zhang, Z., Manzoor, SH, Abdelhamid, MA, & Gul, N. (2026). Cucumber picking robots: Technological progress, challenges, and future directions. *Smart Agricultural Technology*, 13, 101813. <https://doi.org/10.1016/j.atech.2026.101813>.
3. Babenko, D., Dotsenko, N., Gorbenko, O., & Kim, N. (2021). Justification of the introduction of a seed separator for vegetable and tomato crops as part of a technological line. *Ukrainian Black Sea Region Agrarian Science*, 25(2), 80-87. [https://doi.org/10.31521/2313-092X/2021-2\(110\)-10](https://doi.org/10.31521/2313-092X/2021-2(110)-10).
4. Babenko, D.V., Dotsenko N.A., Gorbenko, O.A. (2023). *Mechanics of materials and structures. Part 2: practical training based on interactive graphic and digital content: a textbook*. Mykolaiv: MNAU, 2021. 176 p.

УДК 621.793.7

IMPROVING THE RELIABILITY OF AGRICULTURAL MACHINERY PARTS BY FORMING NANOSTRUCTURED ELECTRIC ARC COATINGS

ПІДВИЩЕННЯ НАДІЙНОСТІ ДЕТАЛЕЙ СІЛЬСЬКОГОСПОДАРСЬКОЇ ТЕХНІКИ ФОРМУВАННЯМ НАНОСТРУКТУРОВАНИХ ЕЛЕКТРОДУГОВИХ ПОКРИТТІВ

Anton Karpechenko, Maxim Bobrov, Danil Makarov

Admiral Makarov National University of Shipbuilding, Mykolaiv, Ukraine

Introduction. Modern agricultural production is characterized by a high intensity of machinery operation, which leads to accelerated wear of working surfaces of components. Tillage, seeding, and harvesting machines are in constant contact with abrasive particles, subjected to impact-cyclic loads, and exposed to corrosive effects of aggressive environments. The primary cause of failure of agricultural machinery is precisely the surface degradation of components, resulting in significant costs for repairs and the procurement of spare parts.