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# EXPERIMENTAL GROUNDING OF THE EFFICIENCY OF THE USE OF ELASTIC OPERATING ELEMENTS IN THE DEVICES FOR PRE-SOWING SEED TREATMENTS

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## ABSTRACT

The article is devoted to the experimental studies of the effect of elastic operating elements of a mixer-dresser on seeds. Conducted experimental studies have shown the effectiveness of using the elastic operating elements for pre-sowing seed treatments. The proposed device is intended for the intensification of the process of mixing and dressing, excluding the traumatizing of seeds, and the harmful effect of protectant preparations on maintenance workers, while simplifying and reducing the cost of construction without additional power inputs. Experimental studies have confirmed the hypothesis, that the use ofshells, made of elastic materials,in the function of mixing devices, significantly reduces the time of preparation of homogeneous mixtures, due to the ability to accumulate the potential energy and to transfer it to the granular material,in the form of kinetic energy of mixed particles motion. Based on the performed researches, 3D model of the device for pre-sowing seed treatments has been developed.

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Hybrid elastic mixer-dressers can be used in agricultural enterprises, dealing with the issues of obtaining multicomponent granular mixtures and seed dressing.

**Keywords**: multicomponent granular mixture, mixer with elastic operating elements, mixer with rigid operating elements, seed dresser, cyclic oscillations, pre-sowing seed treatment.

## 1. INTRODUCTION

We offer a hybrid device of a next-generation "Mixer-dresser" with elastic working elements. There are no exact analogues to such a device.

The purpose of creation the device is to intensify the process of mixing (improving the quality and productivity of the process), elimination of harmful effects of protectant preparations on maintenance workers, simplifying and reducing the cost of construction without additional power input. To facilitate the understanding of this issue, it is enough to note, that the main principle of the hybrid device with an elastic working elements is based on the principle of trampoline.

## 2. METHODS AND RESULTS OF THE RESEARCH

In all existing devices for production of multicomponent agricultural mixtures, the main working element is an auger or other rigid, non-deformable inelastic working element, which requires significant costs for the drive, bruising seeds and interferes with the free redistribution of components inside the mixing device.

In the proposed hybrid devices, working bodies with elastic elements or elastic working bodies are used as operating elements. Unlike rigid inelastic working bodies, elastic operating elements have more freedom and create additional effects on the mixing process, only due to their physico-mechanical properties and design features, without additional energy costs for the drive.

In the mixer-dresser, the main working body is an elasticshell, which, depending on its physical-mechanical and functional properties, can be used in one case as a mixer, in another - as a dresser. The explanation for this fact is quite simple. When dressing, as well as when mixing, it is necessary to mix the components to a homogeneous state. The main difference between the technologies lies in the fact, that during the preparation of the mixture, the components are mixed in the entire volume of the mixer; and when the seeds are treated, the pesticides must be spread over the surface of the seeds, but the process is also carried out in the entire volume of the mixer. For mixing or dressing inside the mixing tank, it is only necessary to select the appropriate operating mode. Therefore, in order to use one device for both mixing and dressing,

it is not necessary to change the drive-the combination of existing devices, driving the mixer. It is enough to replace the working element of the device - the elastic working body.

The researches of many scientists have shown, that the uniformity of protectant distribution on the seeds and the degree of cover with the protectant, as well as the homogeneity of the components mixing,wereprovided by the mutual contact of seeds or the components of mixture, when they were poured freely, without any mechanical impact on them. Elastic bodies provide the best possible free chaotic motion of components in the process of mixing,due to their physico-mechanical properties and design features.

The main requirement for dressing devices is not to traumatize the seeds. In existing dressers, the main working body is a metal screw. And at the same time, it is just the screwthat is the main traumatic device. The proposed hybrid device has another valuable quality, affecting the yield, and, consequently, profitability - the elastic working elements are made of materials, which do not damage the seeds.

The next advantage is that, the proposed devices with the elastic working elements are constructed in such a way, that they protect the environment and maintenance workers from the harmful effect of toxic protectant preparations, since they exclude any possibility of contact with chemical pesticides.

The research was conducted jointly with Czech scientists.

Czech colleagues - co-authors of this work - developed a simulation model of mixing in a shellwith rigid inelastic working bodies. Figure 1 presents the simulation model of mixing in a rigid inelastic shell (Figure 1).

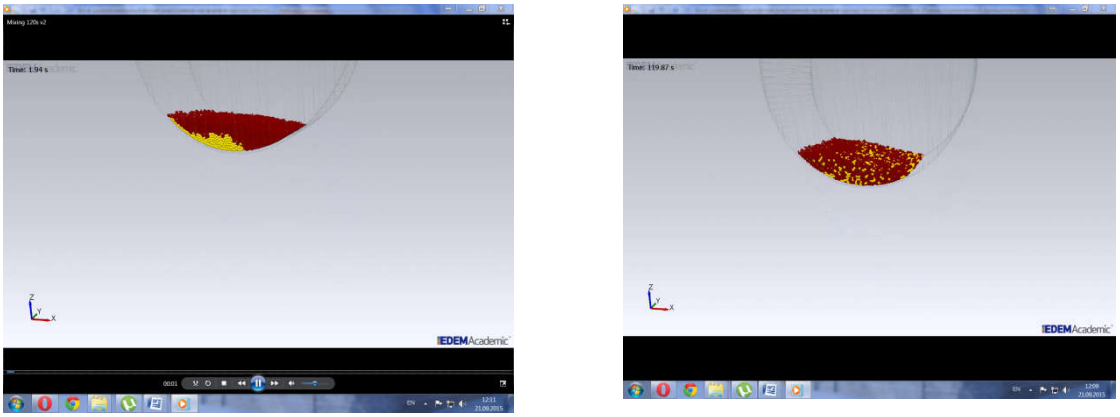


**Fig.1.** Simulation model of mixture production in a mixer with inelastic working elements

On the basis of simulation model, experimental studies were carried out, confirming the assumption, that the use of rigid inelastic working elements adversely affected the integrity of seeds and was inefficient, compared to the use of elastic working elements,which contributed to the intensification of the process of obtaining the multicomponent mixture and did not have a traumatic effect on the seeds.

Comparative results of experimental studies, confirming the effectiveness of use an elastic body in the form of shell,are presented below.

a) b)

a) startof mixing in elastic shell; relative longitudinal deformation of the elastic shellmaterial is **ε=0.40 – 0.45;**

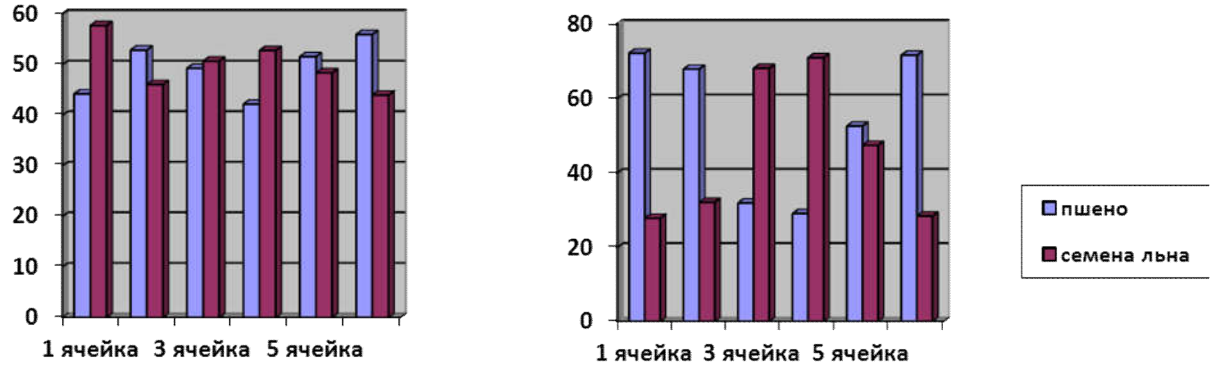
b) start of mixing in rigid shell; relative longitudinal deformation of rigid shellmaterial is **ε=0.1.**

a) b)

a) Elastic shell; the mixture, obtained after 15 seconds of mixing

b) Rigid shell; the mixture, obtained after 2 minutes of mixing

**Fig.2.**The result of mixing in elastic and rigid shells, with sequential arrangement of components




a) b)

| | |
|---|---|
| 1 ячейка, 3 ячейка, 5 ячейка | The 1st cell, the 3rd cell, the 5thcell |
| Пшено | Millet |
| Семена льна | Flax seeds |

Histograms of the distribution of components (in%)(the components of mixture are distributed portionwise along the length of the compartment)

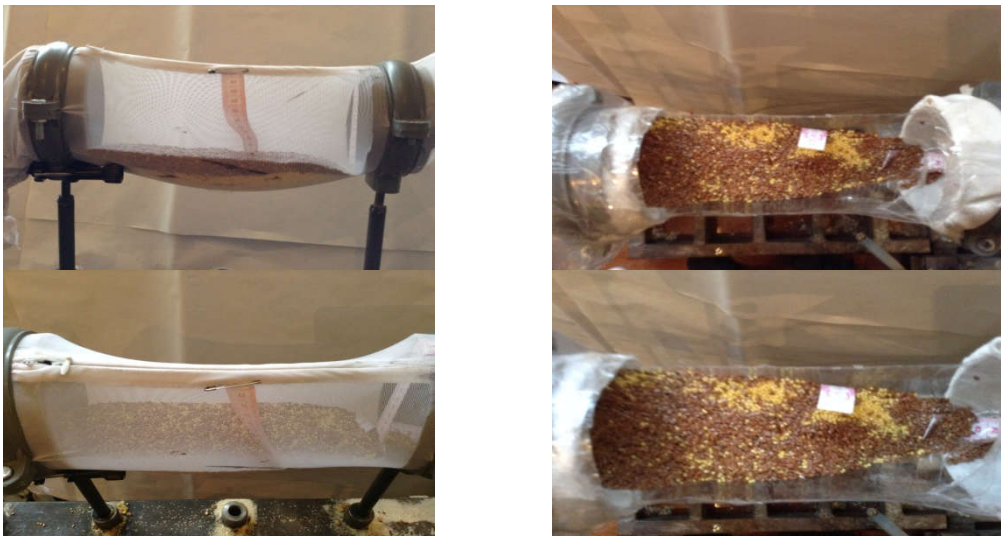
a) in the cells of elastic shell, when mixed for 15 seconds

b) in the cells of rigid shell, when mixing for 2 minutes

**Note**: 100% homogeneity was taken at a 1: 1 component ratio.

**Fig.3.** Histograms of distribution of components in mixers with a sequential initial distribution of components along the length of the mixer

The next cycle of experiments was carried out with layer-by-layer mixing of the components. The test results are shown in the figures.



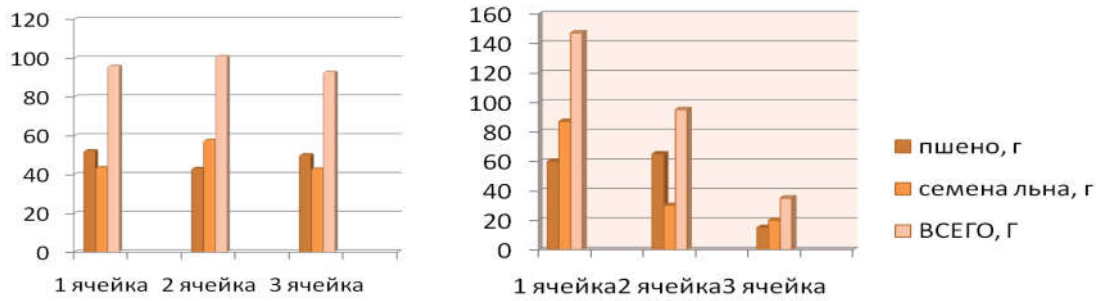
a) b)

a) Mixture, prepared in elastic mixer for one minute

b) Mixture, prepared in rigid mixer for 1min 20sec

**Fig.4.** Layer-by-layer mixing of the components

Figure 5 shows the histograms of the components distribution in the mixture.




a) b)

| | |
|---|---|
| 1 ячейка, 3 ячейка, 5 ячейка | The 1st cell, the 3rd cell, the 5th cell |
| Пшено, г | Millet,g |
| Семена льна, г | Flax seeds, g |
| Всего, г | Total, g |

Histograms of the distribution of components along the length of the shell (in grams) in the process of layer-by-layer mixing

a) in the cells of elastic shell, when mixed for 15 seconds

b) in the cells of rigid shell, when mixing for 2 minutes

**Fig.5.** Histograms of components distribution in mixers with sequential initial distribution of components along the length of the mixer

Based on the researches, a laboratory unit with a capacity of 2 tons/hour was manufactured, 3D model was created (presented in Figure 5), and the design and technical documentation was developed for one of the possible versions of mixer-dresser, with an elastic working element. Experimental studies, confirming the need to create an industrial sample, have been carried out.

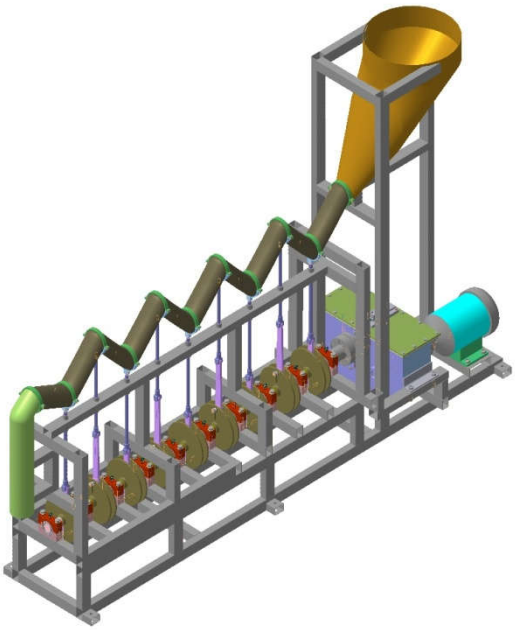


**Fig.6.** 3D model of the device for pre-sowing seed treatment

## 3. RESULTS AND DEDUCTIONS

Experimental studies have confirmed the hypothesis, that the use of shells, made of elastic materials, in the function of mixing devices, significantly reduces the time of preparation of homogeneous mixtures, due to the ability to accumulate potential energy and to transfer it to the granular material, in the form of kinetic energy of mixed particles motion.

## 4. CONCLUSION

The results of multi-year research allow to identify the real benefits for the most conservative estimates, and the most significant advantages of the introduction of hybrid mixers-dressers with an elastic working elements:

1. Reduction and savingof material costs by several times (by 2-4 times). This is achieved due to the following design features of the device:

- hybriddevice "Mixer-dresser" will reduce the cost of preparation of granular forage mixturesand seed dressing, at least twice. This is due to the fact, that instead of two systems of driving mechanisms and devices, performing various technological operations, it is sufficient to use one drive system, replacing only the elastic working element;
- in the design of the proposed device for dressing, there is no need for a separate container for chemical pesticides;
- there is no need to resolve the issue of removal and safe storage of the protectant residues.

2. Resource saving:

- the efficiency of mixing (productivity) is increased by accelerating the mixing process, without increasing the energy consumption at least by a factor of 2;
- seedtraumatizing by the working elements of the dresser is eliminated, that directly affects the seed potential, increases germination and yield;
- power consumption during the process is reduced by 2-3 times, due to the intensification of mixing and reduction in power to the drive; elastic working elements (shell, etc.) are easier and faster to drive, than the rigid working bodies (shell, auger, etc.);
- specific amount of metal per structure is reduced 3-4 times, due to the fact, that the working element of hybrid device is made of rubber-fabric materials (foam plastic, latex and other synthetic materials).

3. Environmental safety:

- there is no need to store the protectant (fungicides and insecticides) in separate containers and their pouring into the dresser;
- safety and ease of storage, subsequent transportation and disposal of the protectant after treatment.

Devices can be used in all agricultural enterprises, involved in the production of multicomponent granular mixtures and seed dressing.

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**CONFLICT OF INTEREST**

The authors confirm that the presented data do not contain the conflict of interest.

**REFERENCES**

1. Henrique, C. Diffusion as mixing mechanism in granular materials/ C. Henrique, G. Batrouni, D.Bideau // Physical Rev. E. 2000. – V.63. – Pp. 1304-1-1304-9.

2. Misonov, V. Application of the Theory of Markovian Chains to Process Analysis and simulation / V.Misonov et al // Presa of Ecole des Mines d'Albi, France, 2000. 61p.

3. Erokhin M.N. Material and technical support of the agro-industrial complex: Textbook for students of universitieson a specialty 311900 "Technology of machine maintenance and repair in the agro-industrial complex" / Joint authors: V.Ya. Limarev et al. - Moscow: Izvestia, 2002. - 462 p.

4. Altshuller G. Find the idea: Introduction to TSIT RIZ - the theory of solving the inventive tasks / Heinrich Altshuller. - 7th ed. - M.: ALPINA PUBLISHER, 2014. - 402p.

5. Ivanov A.P. Dynamics of systems with mechanical collisions. - Moscow: International Education Program, 1997. - 336p.

6. Agricultural machines: grounding the parameters of working elements of the combine harvester: Textbook for students of higher educational institutions, studying in the specialty "Agroengineering". Chernovolov V.A., NesmiyanA.Yu., Arzhenovsky A.G.- Zernograd: FSBEI HE Azov-Black Sea State Engineering Institute, 2013.-144p.: ill. - (textbooks for students of higher educational institutions). -bibliography: p. 84 (16 items).

7. Pat. 2345827 the Russian Federation, IPC B01F 3/18 Method of preparation of a granular materials mixture [Text] / Sukhanova M.V.; Applicant and patent holder - FSBEI HE Azov-Black Sea State Engineering Institute. - №2007113084; pend.09.04.07; publ. 10.02.09, Bul. №4.– 1p.

8. Sukhanova M.V. Substantiation of physical and mathematical model and determination of accelerations under the action of the elastic mixer driving forces – ARPN Journal of Engineering and Applied Sciences, November 2014, Vol.9, №11.

9. Sukhanova M.V., Sukhanov A.V. Prerequisites for creationthe hybrid indistinct-dynamic model for weakly formalized elastic mixing systems - // "Fundamental and Applied Researches in the Modern World" - materials of the International Scientific and Practical Conference, September 30, 2014, Russia, St. Petersburg, p.45-50 Volume 1 – 160p.

10. Pat. 2618106 the Russian Federation, The method of pre-sowing seed treatment and equipment for its implementation [Text] / Sukhanova M.V., Sukhanov A.V., Malinovsky S.V.; Applicant and patent owner Sukhanova M.V. - № 2206101318; pend. 19.01.16; publ. 02.05.17, Bul. №13.- 4p.

11. Sukhanova M.V., Zabrodin V.P. Comparative analysis of the effect of various rigidity surfaces of the working elements of agricultural machinery on a solid particle of a granular material. // Bulletin of Don Agrarian Science of. - 2017. Vol.2, №38. P.19

12. Kovalev, S. Adaptive Approach for Anomaly Detection in Temporal Date, Based on immune Double-plasticity Principle/ S.Kovalev, A. Sukhanov, M. Sukhanova, S. Sokolov // Proceedings of the Second International Scientific Conference "Intelligent Information Technologies for Industry" (IITI17): Volume 1. – Pp.234-243.

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