

"Mixer-Dresser" Hybrid Device

M. V. Sukhanova^{1*}, V. A. Zabrodin², V. P. Bogdanovich³, A. V. Sukhanov⁴, Vitězslav Stýsca¹, Jiri Zegzulka¹, Lucie Jezerska¹ and Jiri Rozbroj¹

¹Azov-Black Sea State engineering institute Federal State Budgetary Educational Establishment of Higher Professional Education (FSBE HPE) "Don State Agrarian University", Zernograd, Lenina str., 21; M.V.sukha.233@yahoo.com, vit.st.bam@yahoo.com, jiri.zeg.233@yahoo.com, lucie.jez.22@yahoo.com, jiri.roz.b21@hotmail.com

²Federal State Budgetary Scientific Institution Northern Caucasian research institute of Mechanization and Electrification of Agriculture; v.a.z.988@gmail.com

³Rostov State University of Railways (FSBE HPE RGUPS), Rostov-on-Don, Rostov Infantry Regiment of the People's Militia square; v.p.bogdan.112@gmail.com

⁴VSb-Technical University Ostrava, ENET Center, Laboratory of Bulk Materials, 17. Listopadu 15, 70833 Ostrava, Czech Republic; a.v.sukh.967@yahoo.com

Abstract

Objectives: The article is devoted to experimental research on the possibilities and the need for a flexible hybrid model mixing-dresser development. **Methods:** The purpose of the device creation is the intensification of mixing and etching (improving the quality and productivity of the process), the exclusion of the harmful effects of etching compounds on service staff at the simplification and design cost reduction without any additional power. **Finding:** The experimental studies confirmed the hypothesis that the use of membranes as mixing devices made of elastic materials, considerably reduces the time of homogeneous mixture preparation due to the ability to accumulate a potential energy and transfer it to a loose body in the form of kinetic motion energy for the mixed particles **Conclusion:** The hybrid elastic mixers-dressers may be used in agricultural enterprises involved in the issues of multi-component granular mixtures production and dressing.

Keywords: Cyclical Fluctuations, Dresser, Multi Component Loose Mixture, The Mixer With Flexible Working Bodies, The Mixer With Hard Working Elements

1. Introduction

We offer a new generation hybrid device "Mixer-dresser" with flexible working bodies. There are no prototypes for this device. The purpose of the device is the intensification of the mixing process (the process quality and productivity improvement), the exclusion of the harmful effects of etching compounds on service staff, the design simplification and cost reduction without any additional power. To understand easier the way of it, it is enough to note that the basic principle of the hybrid device operation with an elastic working body is based on the principle of trampoline action^{1,2}.

2. The Study Methodology and Results

All available and produced mechanical devices for multi-component agricultural mixtures obtaining by the main working body is a screw or another the rigid non-elastic actuator, which requires significant investments for a drive, damaging seeds and preventing the free redistribution of the components inside a mixing device. The proposed hybrid devices use working bodies with elastic elements or flexible working bodies. Unlike hard, inelastic working bodies, the elastic working bodies have more degrees of freedom and provide an additional effect on

*Author for correspondence

the mixing process only due to their physical-mechanical properties and structural features, at no extra energy expenditures for an actuator. In the mixer-seeder, the main working member is a flexible sheath which, depending on its mechanical and physical properties may be used in one case as a mixer and as a seeder in the other. This fact is explained quite simple. It is necessary to mix the components until a uniform compound is obtained during etching, as well as during mixing³⁻⁵. The main difference of technologies is that during the preparation of a mixture, the components are mixed throughout the volume of a mixer, and during dressing, the etching pesticides shall be distributed over the seed surface, but the process is also carried out in the entire volume of the mixer. It is only required to choose a corresponding operation mode for mixing or etching which takes place within a mixing vessel. Consequently, to use a single device for mixing and etching is not necessary to change a drive - a set of available devices, which puts a mixer into motion. It is enough to replace a device working element - a flexible working member. The studies of many scientists proved that a uniform distribution of an etching drug on cypsela and the completeness of coverage by etching, as well as the uniformity of component mixing are provided by a mutual contact of seeds or mixture components at their pouring in a free mode without any mechanical impact on them. The flexible working bodies due to its physical and mechanical properties and design features provide the best free chaotic movement of components during stirring^{6,7}. The primary requirement for dressing devices is not to damage seeds. In existing dressers, the main working body is a metallic screw. Simultaneously, a screw is the primary traumatic device. The proposed hybrid device has another valuable quality, influencing the crop, and hence profit - flexible working parts are made of materials that do not damage seeds. A further advantage is that the proposed devices working with an elastic body are arranged in such a way that they protect against the harmful effects of toxic drugs, disinfectants for environment and a man, as they exclude any chance of exposure to pesticides^{8,9}.

The studies were conducted in cooperation with Czech scientists.

Czech colleagues - the co-authors of this work - developed a simulation model of mixing in a shell with rigid, inflexible working bodies. Figure 1 shows a simulation model of mixing in a hard, inelastic sheath Figure 1. By a

simulation model, experimental studies performed which confirmed the assumption that the use of elastic shells intensifies the process of a multi-component mixture production. The comparative results of experimental studies are presented confirming the effectiveness of flexible working body utilization in the form of a shell Figure 2, Figure 3, Figure 4, Figure 5 shows the histograms of compound component distribution. At this stage of research, a laboratory device is manufactured at the performance of 2th, 3D-model has created the project, and technical documentation is drawn up for one of the possible variants of a mixer-dresser with an elastic working body. Experimental studies performed confirming the pressing need for the creation of one industrial sample at least.

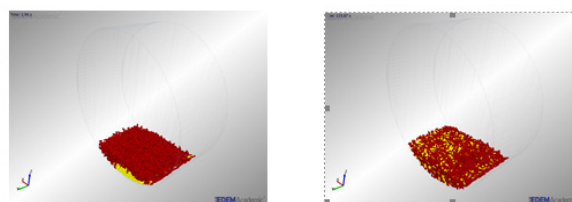


Figure 1. Simulation model of a mixture obtaining in a blender with inflexible working bodies.

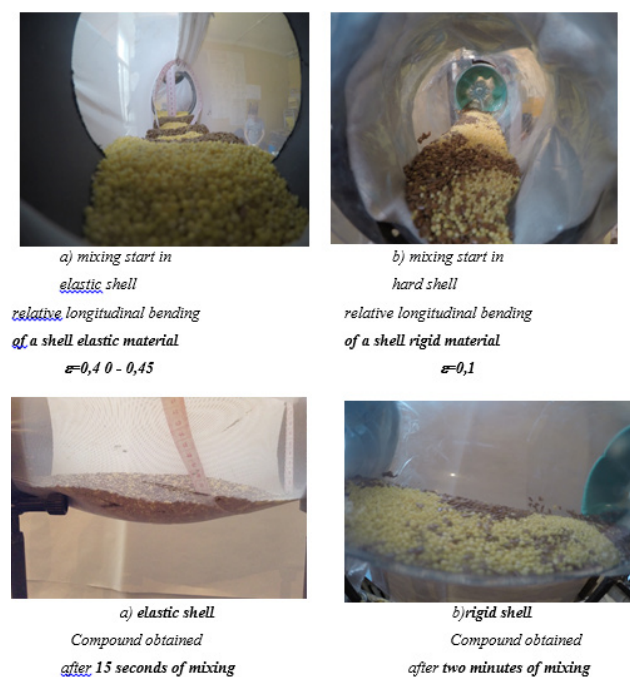
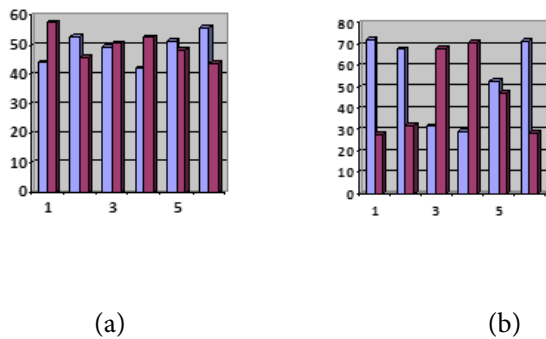
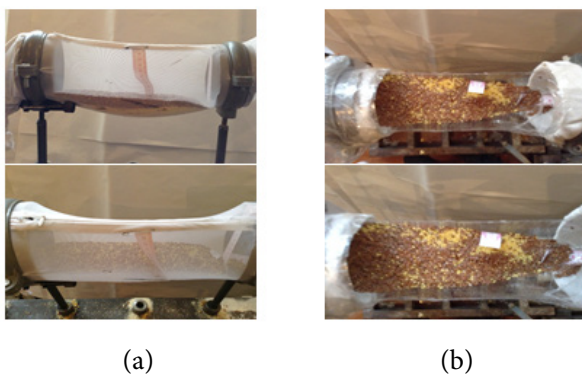


Figure 2. The result of mixing in elastic and rigid shells at sequential arrangement of components.

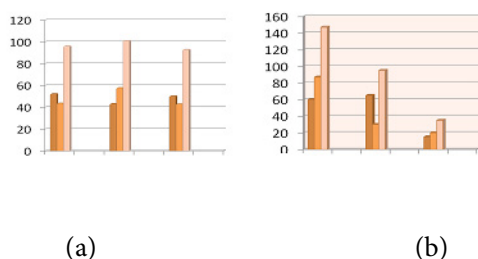


(a) (b)
Component distribution histograms (in %)
(Mixture components are arranged in portions along the compartment length)

Figure 3. Component distribution histograms in mixers at successive initial distribution of the components along the length of a mixer (a) in elastic shell cells during mixing for 15 seconds (b) in hard shell cells during mixing for 2 minutes.



(a) (b)
Figure 4. Component mixing by layers (a) The compound produced in an elastic mixer during one minute (b) The compound produced in a rigid mixer for 1min 20sec.



(a) (b)
Component distribution histograms along a shell length
(in grams) at the layered mixing

Figure 5. The histograms of component distribution in the mixers at a consistent initial distribution of components along a mixer length (a) in elastic shell cells at the mixing during 15 seconds (b) in a rigid shell cells at the mixing for 2 minutes.

3. Results and Conclusions

Experimental studies confirmed the hypothesis that the use of shells as mixing devices made of elastic materials considerably reduces the time of homogeneous mixture preparation due to the ability to accumulate potential energy and transfer it to a loose body in the form of kinetic motion energy of the mixed particles.

4. Summary

The results of many year studies allow to indicate a real benefit according to the most conservative and cautious estimates and the most significant benefits of hybrid mixer-dressers introduction with elastic working body:

4.1 The Reduction and Saving of Costs Several Times (2-4 Times)

This is achieved by the following design features:

- The hybrid device “mixer-dresser” will reduce the costs for the preparation of bulk feed mixes and dressing at least twice since it is sufficient to use a single drive system, replacing a flexible working member instead of the two drive mechanism systems and the devices that perform various processing operations;
- A separate container for pesticides is no longer necessary in the design for an etching device;
- There is no need for addressing the issue of safe storage and the removal of disinfectant residuals.

4.2 Resource Saving

- The mixing efficiency (performance) is increased by speeding up the mixing process without the energy consumption increase at least two times;
- There is no damage of seeds by the working bodies of an etching device that directly affects the potential of seeds, increases germination rate, and productivity;
- The energy consumption of the process is reduced by 2-3 times due to the intensification of mixing and reduction of power to a drive, because elastically flexible operating members (shell, etc.) and will easily lead to a mobile state than the hard working parts (shell, auger, etc.);
- The metallic capacity is reduced 3-4 times because an actuator of a hybrid device is made

of rubber and fabric materials (foam propylene, latex, and other synthetic materials).

4.3 Environmental Safety

- The etching compound (fungicides and insecticides) storage in separate containers and their pouring into a treatment device is not necessary anymore;
- The safety and the ease of storage, subsequent transportation and disposal of a disinfectant after treatment.

The devices may be used at all agricultural enterprises involved in multi-component granular mixture production and dressing.

5. Acknowledgement.

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6. Conflict of Interest

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

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