Mathematic simulation of high-efficiency process of grain cleaning

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Abstract: The article presents the results of field experiment and the results of computer simulation of the grain cleaning process pneumosorting machine PSM-0,5. The results of the comparison of two methods of research are presented.

1. Introduction
Production and processing of grain form in economic system of the country a number of large sectors, such as grain production, the elevator industry, flour-grinding, cereal and feed milling production, which make a grain complex of the country. Value and a role of grain as goods in economy of the state are difficult to overestimate. These are goods which have stable, steady demand at all seasons of the year, in any region, so it is absolutely liquid.

In the conditions of market economy effectiveness of agricultural production is substantially defined by competitiveness of production. Considering these features, production of the majority of types of food products requires integration of several agro-industrial enterprises, which are different in a production orientation.

These circumstances cause relevance of in-depth studies of economic-mathematical models and methods of the analysis and assessment of economic efficiency of technologically integrated grain processing production systems.

Questions of application of mathematical models, methods and means of the informational software for the analysis and assessment of economic efficiency of grain processing production are poorly studied. Relevance of these problems defined the choice of a subject and statement of the purpose and research problems. The pneumosorting machine PSM-0,5 is chosen as an object of a research.

2. Research
At the moment there are two ways of carrying out a research of operation of the pneumosorting machine. The first way is a carrying out field tests which means manufacture of a test piece of the actual sizes or with a scale factor and carrying out numerous laboratory trials. Therefore this method is the most expensive, but at the same time it allows to receive the most precise and reliable results.

The second way - computer simulation which allows to reduce significantly the material inputs (there is no need of creation of actual model and laboratory installations) and to reduce time of
obtaining results. But at the same time it demands creation of the precise detailed computer PSM model with correctly given initial and calculated parameters. At the same time the most long period can be the time spent for creation of computer model, and directly calculation time. Accuracy of similar calculations depends on parameters of a grid of finite elements.

For further acceleration of engineering of new pneumosorting machines it was decided to make computer simulation of process of grain cleaning on the PSM-0.5 device with verification by results of field tests.

In the software package of STAR-CCM+ numerical simulation of grain cleaning in PSM was made. When carrying out a research the geometry of numerical simulation completely coincided with the original of installation. The same as during test boundary conditions were accepted. As a result of computer simulation the following results in a type of volume distribution of fields of vectors of speeds in the channel of the pneumosorting machine were received. They are given on fig. 1 and 2 for mass flow of 0.528 kg/s and on fig. 3 and 4 for mass flow of 0.368 kg/s.

Fig. 1. Scene of distribution of vectors of speeds at the provision of a valve of speed control at the level of 10 of a graduated scale.
Fig. 2. Scene of distribution of vectors of speeds at the provision of a valve of speed control at the level of 5 of a graduated scale.

Analyzing the received results on fig. 1 and 2, it is possible to draw a conclusion that input speed to the pneumosorting canal is more than admissible one at which grain will be carried away to the pneumosorting canal. It will have an adverse effect on quality of operation of the pneumosorting machine.

In connection with the received results of computer simulation it is decided to conduct a research with smaller mass flow of air.

On the profiles of speeds given on fig. 3 and 4, we can see, that after replacement of the blower and the electric motor speed reaches desired values and becomes the same as in the existing installation. Thus, at less potent electric motor input speed to the pneumosorting canal remain the same and quality of cleaning remains the same.
Fig. 3. Scene of distribution of vectors of speeds at the provision of a valve of speed control at the level of 10 of a graduated scale.

Fig. 4. Scene of distribution of vectors of speeds at the provision of a valve of speed control at the level of 5 of a graduated scale.
Fig. 5. The schedule of comparison of results of a natural experiment and data of computer simulation in the software package of Star CCM+.

Comparing results on fig. 5 it is possible to tell that the results received by a numerical experiment slightly differ from the values received by a physical experiment. Unessential mistakes of carrying out a physical experiment are a consequence of errors of devices. Also in a numerical experiment the ideal model is shown where the camera is absolutely tight, at a physical experiment it is difficult to reach it.

3. Conclusion

Thus, it is possible to draw a conclusion that the values received at computer simulation in the program complex STAR-CCM+ can be used at engineering of new pneumosorting machines.

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