UDC 574

FEATURES OF DETERMINING THE ECOLOGICAL STATE OF AGRICULTURAL LAND BASED ON THE RESULTS OF ELECTROMAGNETIC SEPARATION FOR CEREALS AND GRASS FLOUR

A.V. Cheremisin[1,2], S.M. Logunov[1], R.V. Davidov[1], A.P. Glinushkin[2], M.E. Kulikova[1], A. I. Nagornaya[1]

[1] *Peter the Great Saint Petersburg Polytechnical University*
Russia, Saint Petersburg, 195251, 29 Polytechniheskya str
[2] *All Russian Research Institute of Phytopathology*
Russia, Moscow Region, 143050, Moscow Region, Odintsovo district, B.Vyazyomy, Institute str., ownership 5
e-mail: sema-logunov@ya.ru

The food and processing industry is one of the priority areas of the Russian economy. In conditions of population growth, as well as various unfavorable climatic factors affecting the ripening and harvesting processes, there is a constant need for high-quality collection, processing, storage and rational use. The latter depends very much on processing. There are many ways of processing various agricultural products. But in each of them there are separation processes aimed at isolating from it foreign particles that are dangerous, both for living organisms during its consumption after processing, and for machines used in processing industry.

We suggest one of the possible options for assessing the pollution of the field based on the results of electromagnetic separation collected from this field of agricultural products of cereals or herb flour. The harvested grain crop or herb flour, as previously noted, contains metal particles in its composition, the number of which increases with the amount of debris (including stones) that has got into the moving parts of the harvesting machine, as well as the degree of wear of its mechanisms. These particles can damage the working bodies of processing machines, accelerate their wear, cause arcing, followed by ignition and explosion in industrial premises [1-3] When these particles get into the organisms of animals and poultry during feeding in most cases, their death occurs. Therefore, to prevent the considered severe consequences, the separation of these particles from agricultural products by means of electromagnetic separation takes place. Numerous studies have shown that very much depends on the quality of electromagnetic separation of agricultural products.

At present, several different methods have been developed to monitor the state of the magnetic field, the most common of which is using a thin magnetic film. But in the interpolar space, it is not very effective. The method based on the use of a matrix consisting of Hall sensors, placed at a fixed distance from each other with large dimensions of the magnetic system, is also ineffective. In addition, there are problems with its attachment to measurements in the interpolar space and fixation with the required accuracy of the distance as it moves between the poles. The method of controlling the parameters of a magnetic field developed by us on the basis of recording a diffraction image transmitted through a ferrofluidic cell of laser radiation is fairly simple to operate and reliable in application[4-7]. In Fig. 1, an example is given of a diffraction pattern (after computer processing) of the laser radiation transmitted through the cell in the direction perpendicular to the induction of the magnetic field B_0.

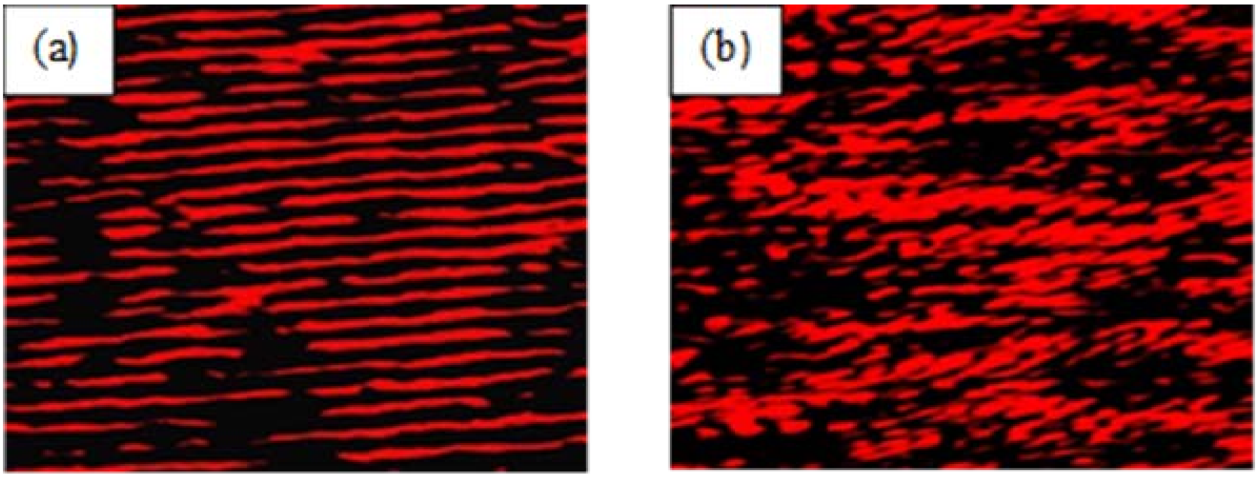

Fig. 1. Diffraction pattern of laser radiation in the case of placing a ferrofluidic cell from a magnetic fluid: (a) in a homogeneous magnetic field; (b) in an inhomogeneous magnetic field.

The resulting image allows to determine the degree of inhomogeneity from the distance between the maxima, and also to adjust the magnetic system when the electromagnet is energized in real time, since this image can be stored, for example, in the laptop's memory. With the definition of distance, there is also no problem, since the ferrofluidic cell is placed on a moving table of non-magnetic material, the support of which moves in two planes.

Experimental studies on the separation of three samples of a dry mixture of herbal flour collected in several fields of the Leningrad Region were carried out on a laboratory installation based on an electromagnet with induction B0 varying in the gap between the poles from 0.0004 to 0.9623 T at a distance l = 42 cm, h = 15 cm. The working diameter of the flow of the dry mixture in the gap between the poles was 3.6 cm. The separation efficiency in 2 hours was 2 bags of a mixture of herb flour. From each field, two bags of a dry mixture were electromagnetically separated.

The metal particles collected after the separation of the mixture from each field were weighed and their visual evaluation was carried out according to their dimensions.

From the separated mixture of herbal flour (for each field), 10 samples were taken, which were checked for the presence of metal particles in them by nuclear magnetic resonance and X-ray spectroscopy.

Also, data were obtained on the state of the fields on which the grass was harvested for which the herb flour was made. The condition of the two fields by the presence of rubbish and stones on them was approximately the same, the difference in cleaning was the period of operation of agricultural machinery. For the third field harvesting technique was quite new, but the contamination of this field compared to the other two was significant (several times).

The conducted studies of control samples of samples of mixtures of herbal flour after its separation showed the absence of metal particles in them, which confirms the high quality of the separation carried out.

The results obtained by the number of metallic impurities indicate the need for an urgent ecological survey of the field condition followed by its purification, since during the harvesting a considerable deterioration of the agricultural machinery takes place.

Table 1

The separation results and the life of the equipment

№ of magnetic field	The degree of pollution and types of debris on the field	Service life of harvesting equipment	The amount of metal particles in grams
1	Small stones, branches from trees and shrubs, small metal objects, very rare plastic	more than 15 years	3.7
2	A similar situation, as in the first field	more than 15 years	4.4
3	Stones of various sizes, parts of construction debris, various metal objects, plastic and wood	less than 5 years	11.2

A preliminary analysis of the results shows that the methodology we proposed for assessing the state of farmland based on the results of electromagnetic separation of the harvested crop is workable. According to the results of electromagnetic separation, as subsequent studies show, even in most cases it is possible to determine the degree of pollution of the field and the need for environmental monitoring on it, without additional costs and a thorough (with an accuracy of up to a year) period of operation of agricultural machinery.

References:

1.Rychkov M. M., Chakhlov V. L., Chertov A. S. (2003) A Betatron with Magnetic Biasing and an Extracted Electron Beam. *Instruments and Experimental Techniques* 46(4): 541-544.

2.Bazarov, B.A., Galaidin, P.A., Silaev, A.A., Marusin, M.P., Zakemovskaya, E.Y., Gilev, A.G., Alekseev, A.V. (2014) A Magnetic System Based on Permanent Magnets for a Flowmeter of Multiphase Fluid Media. *Measurement Techniques* 57(4): 217-220.

3.Cherepov S. V., Moroz O. Kh., Derecha D. A., Hesse O. (2011) A scanning visualizer of the magnetic field distribution. *Instruments and Experimental Techniques* 54(2): 273-275.

4.Davydov V. V., Dudkin V. I., Karseev A. Yu. (2015a) Nuclear-resonance magnetometer with a flowing liquid to measure weak fields. *Technical Physics* 60(3): 456-460.

5.Davydov V.V., Myazin N.S. (2017) Measurement of Magnetic Susceptibility and Curie Constants of Colloidal Solutions in Ferrofluid Cells by the Nuclear Magnetic Resonance Method. *Measurement Techniques* 60(5): 491-496.

6.Logunov S E, Davydov V V, Vysoczky M G, Koshkin A Yu, Rud' V Yu. (2017) Quantum analyzer of force lines structure at magnetic fields. *Journal of Physics: Conference Series* 917(5): 052028.

7.Logunov S.E., Koshkin A.Yu., Davydov V.V., Petrov A.A. (2016) Visualizer of magnetic fields. *Journal of Physics: Conference Series* 741(1): 012092.