STUDY OF THE OPTIONAL OPTION OF THE MEASURING CELL FOR DETERMINING THE DIELECTRIC PERMEABILITY OF MULTICOMPONENT MIXTURES

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In order to increase the efficiency and level of automation of plants for processing the seeds of agricultural plants in strong electric fields, the problem of determining the electrophysical properties of both the seed mass and each component arises. To solve this problem, the work defines a method for assessing the dielectric constant of the seed substance, since the most common methods are the dielectric constant of a mixture (for seeds of agricultural plants, air and the actual seed). A comparative analysis of the constructions of measuring cells for determining the dielectric constant was also carried out, and the feasibility of using a measuring cell with compensating electrodes was determined.
Keywords: *multicomponent mixture, dielectric constant, Kraft effect, electric potential, capacitor*

Relevance of work. During the development and design of electrotechnological installations for the processing of seeds of agricultural crops in which the technological process is implemented by electric discharge technologies, a problem arises in determining the characteristics of the working environment. In particular, it is necessary to know the value of the dielectric constant of the product and its components, as these parameters significantly affect the parameters of the chamber for product processing and, from time to time, the parameters of the installation. Currently, there are methods that allow determining the dielectric constant of heterogeneous media with sufficient accuracy. However, there is a problem in determining, with sufficient accuracy, the dielectric constant of the components of multicomponent mixtures.

The purpose of the development is to determine the parameters of the measuring cell for determining the dielectric constant of multicomponent mixtures for studying the dielectric constant of agricultural crop seeds.

Research results. During the development and design of electrotechnological installations for the processing of agricultural products, in which the technological process is implemented by electric discharge technologies, there is a problem in determining the characteristics of the working environment. In particular, it is necessary to know the value of the dielectric constant of the product and its components.

The cell for measuring the dielectric constant is a capacitor, and the accuracy of the measurement depends on the accuracy of determining the capacitance of the capacitor and reducing the parasitic capacitance. However, the formula for the capacitance of a planar capacitor is strictly valid only for an ideal planar capacitor with an infinite surface area.

In a real capacitor with a finite area of the covers, there is an edge effect - displacement of the field (Fig. 1). In this work, it is proposed to use a capacitor with an additional electrode to eliminate the edge effect.

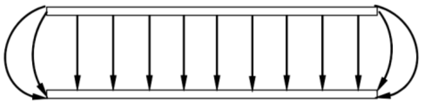


Figure 1 - Edge effect in a flat capacitor

The simulated design of the developed measuring cell is shown in Fig. 2.

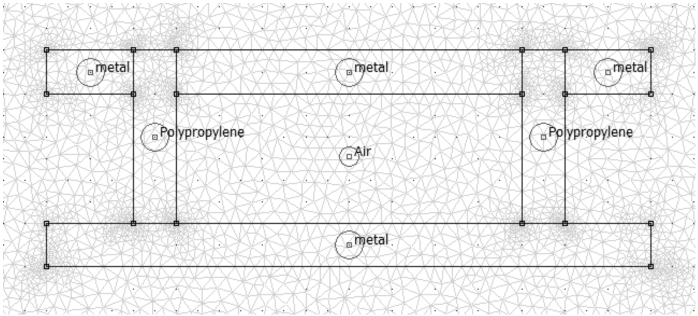


Figure 2 - Modeling of the measuring cell using the FEMM 4.2 package

In order to confirm the feasibility of using this design, it is necessary to determine the characteristics of the electric field in the measuring capacitor.

To solve the problem, the numerical method of upper relaxation was applied [1]. The software [2] implemented on the basis of this method was successfully used to analyze the operation of various nodes of high-voltage equipment. In the Cartesian coordinate system:

$$\frac{\partial}{\partial x}(\varepsilon\frac{\partial\varphi}{\partial x})+\frac{\partial}{\partial y}(\varepsilon\frac{\partial\varphi}{\partial y})=0, \quad (1)$$

whereσ - specific electrical conductivity of the environment; $\varepsilon = \varepsilon_r\varepsilon_0$ – dielectric constant; x, y are Cartesian coordinates.

According to the known potential distribution, the electric field intensity vector E and its modulus are determined using the equations:

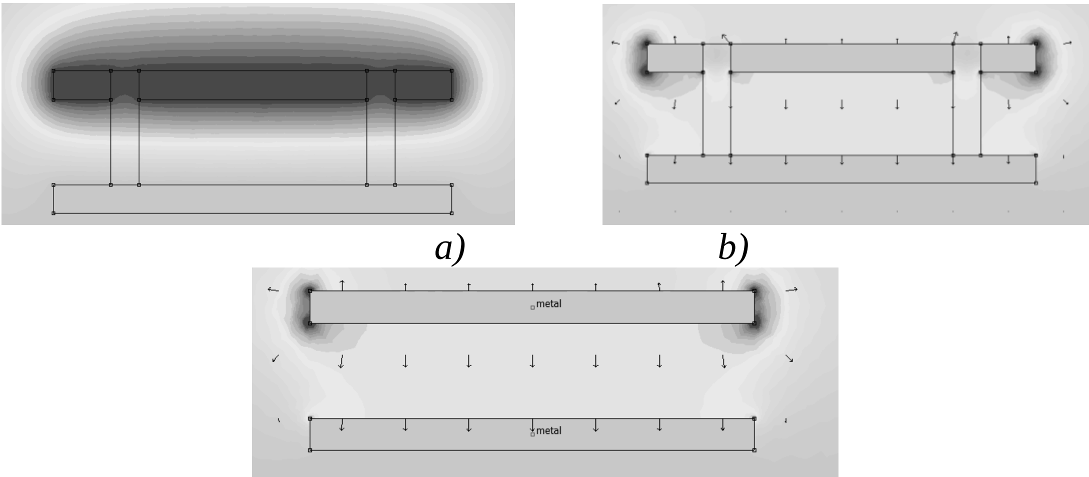
$$\overline{E} = -grad\varphi = -\left(r\bar{i}\,\frac{\partial\varphi}{\partial x} + \bar{j}\,\frac{\partial\varphi}{\partial y}\right), \quad (2)$$

$$|E| = \left[\left(\frac{\partial\varphi}{\partial x}\right)^2 + \left(\frac{\partial\varphi}{\partial y}\right)^2\right]^{0.5}. \quad (3)$$

The triangles on the diagram (Fig. 2) show the division of the computational domain by the finite element mesh.

For an unambiguous solution to the problem, Dirichlet boundary conditions were set with a zero value of the potential on all outer boundaries of the calculation area (Fig. 2). The electrical potentials of the electrodes of the measuring cell in relative units had values of one (on the upper electrodes) and zero (on the lower electrode).

The simulation results of the spatial distribution of the electric potential in the volume of the discharge chamber between the high-potential and low-potential electrodes, obtained using the upper relaxation method [3], coincide with the simulation results obtained using the FEMM4.2 object-oriented package and are shown in Fig. 3, a.



a) *b)*

c)

Figure 3 – Distribution of electric potential in the volume of the measuring cell (a), in the volume of the measuring cell without compensating electrodes (b), in the volume of the measuring cell with compensating electrodes (c)

In fig. 3, b shows the distribution of the electric field strength in the volume of the measuring cell without compensating electrodes, and Fig. 3, c also shows the distribution of the electric field strength in the volume of the measuring cell with compensating electrodes.

Conclusion. When analyzing the mathematical modeling of the electric field intensity distribution, it should be noted that the use of additional compensating electrodes leads to an increase in the uniformity of the characteristics of the electric field in the volume of the measuring cell, and therefore increases the accuracy of determining the capacitance, and reduces the influence of parasitic capacitances on the measurement result. Therefore, it should be noted that the proposed electrode system of the measuring cell allows to minimize the edge effect and carry out measurements with sufficient accuracy.

R e f e r e n c e s

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АНАЛІЗ ПІДХОДІВ ДО ОЦІНКИ ЕФЕКТИВНОСТІ ФУНКЦІОНУВАННЯ ГІБРИДНОЇ СИСТЕМИ ЕЛЕКТРОЖИВЛЕННЯ ЛОКАЛЬНОГО ОБ’ЄКТА

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ANALYSIS OF APPROACHES TO ASSESSMENT THE EFFICIENCY OF FUNCTIONING OF THE HYBRID POWER SUPPLY SYSTEM OF A LOCAL FACILITY

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The paper deals with the main approaches to determining the criteria for evaluating the operation of a hybrid power supply system of a local facility based on a photovoltaic battery and/or a wind turbine with storage batteries and with a connection to the distribution grid. It is shown that the indicator of the minimum cost of electricity produced by the system found the most widespread use. A brief analysis of the software products for the general evaluation of the operation of the hybrid power supply system was carried out. The use of the cost reduction factor for operational evaluation of the functioning efficiency of the hybrid power supply system is substantiated.

Keywords: *hybrid power supply system, photovoltaic battery, wind turbine, coefficient of cost reduction, local facility.*

Актуальність дослідження зумовлена тим, що в сучасних умовах набирає обертів тенденція поширення підключених до розподільної мережі гібридних систем на основі фотоелектричної батареї (ФБ) та/або вітрогенератора (ВГ) з акумуляторними батареями (АКБ) для використання на локальних об’єктах (ЛО) відносно невеликої потужності (до 20-50 кВт). Актуалізація цієї тенденції пов’язана з необхідністю налагодження електропостачання ЛО військового