Physicomathematical models of seeds and errors in calculating the volume of an electro terminator filled with seeds

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Abstract The article provides data on the impact of high-voltage current of electric spark discharges on the culture of gummosis located on the surface of cotton seed, and the article presents data on the impact of high-voltage electric spark discharges on the gummosis culture located on the surface of the cotton seed. In this case, cotton seeds were taken as the basis for the physical model, consisting of three component parts, respectively, having a chalazal part, a lateral part, and a micropile. In the initial period of seed treatment, moisture penetrates the inside of the seed from the outside. Studied three-dimensional volumetric figures (hemisphere, cylinder, cone, etc.), carried out a literature review and mathematical calculations determined the calculation errors. The vessels of various shapes were compared. The prerequisites for determining the calculation errors have been made.

1 Introduction

In Uzbekistan, the affection of cotton by gummosis in different years manifested itself in different ways. However, the consequences are drastically reflected in the quality of the fiber and lead to yield losses. Many studies to combat gummosis disease have been based on the use of pesticides. Pesticides negatively affect the health of people and warm-blooded animals, pollute the environment. Electrospray treatment of cotton seeds to disinfect them from gummosis disease is an environmentally friendly technology and helps to improve the ecological situation in the region [1].

A.A. Babayan, in his article "Methods of centralized dressing of cotton seeds" [2], writes that dressing of cotton seeds is mainly directed against gummosis, which is the most common disease of this crop. It is also noted here that, depending on the climatic conditions of the area, the degree of resistance of the cultivated variety to diseases, the agricultural technology used, the harm from gummosis can reach different sizes (for example, in Armenia, before the obligatory use of dressing in 1929 and 1930, the damage rate of cotton in% was 40 and 9-23).

In the literature [3], there is evidence that cotton seeds in the middle part (about 1/3 of the length of cotton seeds) have a cylindrical shape. Assuming that the chalazal part has an

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ideal hemispherical shape and that part of the micropile has the shape of a cone, we obtain a conditional division of the cotton seed into three equal parts (see Fig. 1).

Based on the experimental data [3], confirming the passage of the electric spark discharge current over the surface of the seed, let us determine the part of the seed backing with the height Δ and the specific electrical resistance ρ to calculate the leakage current over the surface of the equivalent cylinder [3]. At the same time, for theoretical studies, the surface resistance of moistened cotton seeds is assumed to be the same over the entire surface.

To calculate the equivalent cylinder, it is necessary to reduce the chalazal part (1, Fig. 1) and the micropile part (3, Fig. 1) to an equivalent cylinder with the same base. For further calculations, we used these three particular cotton seed models.

Volume of hemisphere $V_{hemisphere}$ and cone V_{kon} equals, respectively:

$$V_{hemisphere} = \frac{2}{3} \pi \cdot r^3 [m^3] \tag{1}$$

$$V_{kon} = \frac{1}{9} \pi \cdot r^2 \cdot L [m^3] \tag{2}$$

where: r is the radius of the base of rotating bodies, m; L is the length of the cotton seed, m.

Fig.1. To calculate the conduction current over the surface of a moistened seed: a) cotton seed and dividing it into three equal parts: 1 is chalaza; 2 is middle; 3 is micropile; b) an equivalent cylinder of cotton seed.

From the formula (1) we find the height h_c of the equivalent cylinder of the hemispherical part of the cotton seed:

$$h_c = \frac{2}{3} \cdot r[m] \quad (3)$$

And from (2) we find the height h_k of the equivalent conical part of the cotton seed:

$$h_k = \frac{L}{9}[m] \quad (4)$$

By joining the cylinders, we obtain a total equivalent cylinder of a cotton seed with a height H_{ekv} :

$$H_{ekv} = h + h + h = \frac{1}{9} \cdot (6r + 4L)[m] \quad (5)$$

It is known that [3] that the current over the surface of a cylindrical insulator is determined by the formula:

$$I_{cond} = \frac{U_{discharge}}{R_{cond}}[A] \quad (6)$$

where, R_{cond} is conductivity resistance on the cylinder surface, Ohm; $U_{discharge}$ is spark discharge voltage, kV.

In the above work [3], the seeds were exposed to high voltage electric spark discharges. This work is devoted to the electrical treatment of moistened cotton seeds with an alternating electric current with a voltage of up to 1000 V. The process is carried out in an electric terminator under the influence of alternating current.

Statement of the problem. The different type of shape when calculating the size of the seed leads to difficulties and errors in determining its size. At the same time, the development of a method for minimizing errors is considered problematic, and in this work, initial calculations were performed to solve the problem.

2 Methods

In general, it is easy to assess uncertainty. To estimate the uncertainty inherent in any measurement result, the following steps should be taken [4].

First step. The measured size will be described. It is important to know exactly what is being measured, including the relationship between the size of the measurement and its parameters. Where possible, adjustments will be made to certain systemic effects. Such descriptive information is usually provided in an appropriate methodology document or other method description.

Second step. Sources of uncertainty are identified, and a list of sources of uncertainty is compiled. It includes sources that contribute to the parameter uncertainty in the same proportions as those identified in the first step but may also include other sources of uncertainty.

Step three. A quantitative description of the components of uncertainty. The uncertainty value specific to each identified potential source is identified and estimated. It is often possible to estimate or identify a single contribution of uncertainty from multiple sources. It is also important to consider that the available data adequately account for all sources of

uncertainty. Additional experiments and studies need to be carefully planned to ensure that all sources of uncertainty are adequately addressed.

Fourth step. Calculation of the final uncertainty. The information obtained in the third step consists of several quantitatively described properties that are subject to general uncertainty or are associated with individual sources or with the final effects (effects) of several sources. These properties must be expressed in the form of standard deviations and combined to obtain the final standard uncertainty following current regulations [4].

Many researchers have considered methods of calculating three-dimensional bodies, convex bodies. In these works, mathematical formulas and various research methods are given in detail [5-15].

3 Results and Discussions

Dimensions of cylindrical seeds: calculate the size of the radius of 3 mm:

$$V_{ch} = 3.14 \cdot 0.003 \cdot 0.003 \cdot 0.008 = 0.000000226 \text{ m}^3 = 226 \text{ mm}^3$$

Size of cylindrical container:

$$V_{dish} = 3.14 \cdot 0.03 \cdot 0.03 \cdot 0.16 = 0.000452 \text{ m}^3 = 452 \text{ sm}^3 = 452000 \text{ mm}^3$$

Quantity of seeds in a container:

$$n = \frac{V_{dish}}{V_{chigit}} = \frac{452000}{226} = 2000$$

Fig.2. Electronic Cotton Seed Model

Figure 2. presented an electronic model of cotton seed. Such a model makes it possible to calculate the volume of seeds more accurately and makes it possible to estimate the calculation errors using a spreadsheet of a personal computer.

We calculate the seed size of this type:

$$V_{ch2} = V_1 + V_2 = \frac{4}{6} \cdot \pi \cdot r^3 + \frac{1}{3} \cdot \pi \cdot r^2 \cdot h = \frac{4}{6} \cdot 3.14 \cdot 0.003 \cdot 0.003 \cdot 0.003 + \frac{1}{3} \cdot 3.14 \cdot 0.003 \cdot 0.003 \cdot 0.004 = 5.62 \cdot 10^{-8} + 1.256 \cdot 10^{-5} = 9.42 \cdot 10^{-8} \text{ m}^3 = 94 \text{ mm}^3$$

Quantity of seeds in a container:

$$n = \frac{V_{idish}}{V_{chigit1}} = \frac{452000}{94} = 4808 \text{ pieces}$$

$$\text{Error} \frac{4808-2000}{4808} * 100\% = 58.4 \%$$

Dimensions of cylindrical seeds: calculate the size of the radius of 3 mm:

$$V_{ch} = 3.14 \cdot 0.003 \cdot 0.003 \cdot 0.008 = 0.000000226 \text{ m}^3 = 226 \text{ mm}^3$$

Size of cylindrical container:

$$V_{idish} = 3.14 \cdot 0.03 \cdot 0.03 \cdot 0.16 = 0.000452 \text{ m}^3 = 452 \text{ sm}^3 = 452000 \text{ mm}^3$$

The size of the metal rod (electrode):

$$V_{ster} = \pi \cdot r^2 \cdot h = 3.14 \cdot 0.003 \cdot 0.003 \cdot 0.16 = 0,0000045216 \text{ m}^3 = 4521.6 \text{ mm}^3$$

$$\text{Working size } V_{ishchi} = V_{idish} - V_{ster} = 452000 - 4521.6 = 447478.4 \text{ mm}^3$$

$$\text{Quantity of seeds in a container: } n1 = \frac{V_{idish}}{V_{chigit1}} = \frac{447478.4}{226} = 1979 \text{ pieces}$$

$$\text{Quantity of seeds in a container: } n2 = \frac{V_{idish}}{V_{chigit2}} = \frac{447478.4}{94} = 4760 \text{ pieces}$$

$$\text{Error} \frac{4760-1979}{4760} * 100\% = 58 \%$$

$$V_{ch1} = 2 \cdot V_1 + V_2 = \frac{4}{6} \cdot \pi \cdot r^3 + \pi \cdot r^2 \cdot h = 2 \cdot \frac{2}{3} \cdot 3,14 \cdot 0,003^3 + 3,14 \cdot 0,003^2 \cdot 0,005 \\ = 0,0000002543400 \text{ m}^3 = 254.3 \text{ mm}^3$$

$$V_{ch2} = \frac{4}{3} \cdot \pi \cdot r^3 = \frac{4}{3} \cdot 3.14 \cdot 0.004^3 = 0,0000002679467 \text{ m}^3 = 267.9 \text{ mm}^3$$

$$\text{Quantity of seeds in containers: } n1 = \frac{V_{idish}}{V_{chigit1}} = \frac{452000}{254.3} = 1777 \text{ pieces}$$

$$n2 = \frac{V_{idish}}{V_{chigit2}} = \frac{452000}{267.9} = 1687 \text{ pieces}$$

Fig.3. Two forms of the electrical terminator vessel (top view)

Figure 3 shows the cross-sectional areas of a metal vessel of two shapes (top view). The central electrode for electrothermal treatment of cotton seeds is not visible in these images. And in Figure 4, this electrode is visible in the vessel's center and has a red-brown color.

Error $\frac{1777-1687}{1777} * 100\% = 5 \%$

Fig.4. General view of an electric terminator for electric processing of cotton seeds.

4 Conclusions

The paper deals with issues related to mathematical and physical modeling of cotton seeds. The different type of shape when calculating the size of the seed leads to difficulties and

errors in determining its size. In particular, a model of cotton seed has been created, which consists of three parts: the chalazal part, the lateral part, and the micropile. The relevant literature has been analyzed. Illustrative materials are presented, modern methods of calculation and modeling with the use of computer programs are studied and applied. The prerequisites for determining the calculation errors have been made.

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