SELECTION OF ELECTRIC ALFALFA CLEANER TECHNOLOGY FROM SEEDS OF QUARANTINE PLANTS

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Annotation: Proceeding from basic properties of alfalfa seeds the paper substantiates the constructive scheme of their cleaning from seeds of quarantine plants. For sorting and cleaning of alfalfa seeds the constructive scheme consisting of concentric cylindrical electrodes with increasing intensity of electric field in the direction of seed movement is adopte

Keywords: Alfalfa, weeds, seeds, properties, cleaning.

To ensure food security in Uzbekistan through the production of livestock products in sufficient quantities, it is necessary to create a sustainable fodder base. This problem can be solved primarily through preparation of high quality alfalfa seeds. According to the Ministry of Agriculture of the Republic of Uzbekistan, the total area under alfalfa in recent years varies in the range of 90 thousand hectares, for the conservation of which, based on the calculation of 5-year grass stand, about 270 tons of seeds need to be prepared annually [1].

Despite very favorable soil and climatic conditions in the country, the average yield of alfalfa seeds on irrigation remains at a rather low level (about 1.5 cwt/ha). The main reasons for this situation are low farming techniques, weed infestation of the fields, lack of special technical means for cleaning, sorting and conditioning of seed material, which often leads to increased losses of quality seeds in waste and weed infestation of seeds of crops.

The existing technology of seed cleaning provides the use of a complex of machines consisting of thresher-weaver MV-2,5A, cleaner of pile of seeds OVS-28, cracker K-0,5A, cleaner Petkus-Selektra, trier BT-20, pneumosorting table PSS-2,5 and electromagnetic cleaner EMC-1A. Large metal and power consumption, significant cost of manual labor and capital investments hamper the use of this seed cleaning complex in terms of seed farms.

The principle of operation of electromagnetic seed cleaning machine EMS-1A designed for final cleaning of alfalfa seeds from difficult to separate weed seeds (dodder, humus, couch grass, bitterroot, etc.) is based on the ability of weed seeds to be enveloped by special magnetic powder (trifolin), which is harmful to the environment and human. In addition, the seed material must be well dried and undergo preliminary preparation consisting of 15 or more operations before passing through [2].

Analysis of technological process of existing seed-cleaning machines and methods of seed cleaning of agricultural crops showed that in order to improve the quality of seed material the most pros- tic and effective way is the use of electric field forces [3]. However, the use of triboelectric [1] and dielectric [4] devices did not help to achieve cleaning of alfalfa seeds from seeds of quarantine plants to the level of their requirements [5].

Electrostatic separators with diverging flat electrodes (figure1) use the effect of seed orientation along the length in the direction of electric field lines whose torque is inversely proportional to the sphericity coefficient of the seeds. I.e., elongated seeds with a smaller sphericity coefficient are oriented faster in such fields than seeds with a larger sphericity coefficient and they start earlier, moving in the direction of the upper electrode with the opposite sign of the field.

Studies [6] have shown that the average length of alfalfa and bittercane seeds are 1.85 and 2.87 mm, i.e., bittercane seeds are 1 mm longer than alfalfa seeds. To a lesser extent, they differ in thickness, which is, respectively, 0.85 and 1.05 mm, and their distribution curves overlap each other to the greatest extent. The widths of the same seeds are 1.58 and 1.97 mm. Taken together, the above data indicate the possibility of using the differences in their shape for sorting and cleaning, because their behavior under the influence of an external electric field, other things being equal, depends on the coefficient of sphericity, which is determined by the formula

$$K= (b+c)/2a, \qquad (1)$$

where a, b, c are the length, width and thickness of the seed, mm;

Calculations of sphericity coefficients according to (1) show that this index for alfalfa and bittercane seeds averages 0.657 and 0.426. Based on the above, we can assume that mustard seeds start to the upper electrode at lower electric field strengths than alfalfa seeds, because they have a longer length and a smaller sphericity coefficient.

The use of electrostatic separators with diverging flat electrodes, in which the field strength and the value of the acquired charge are increasing, create a good opportunity to change the trajectories of alfalfa and bittercane seeds during their movement to the upper electrode after separation from the potential lower electrode [7]. In this case, mustard seeds start to the upper electrode at lower voltages than alfalfa seeds, because they have a longer length and a smaller sphericity coefficient.

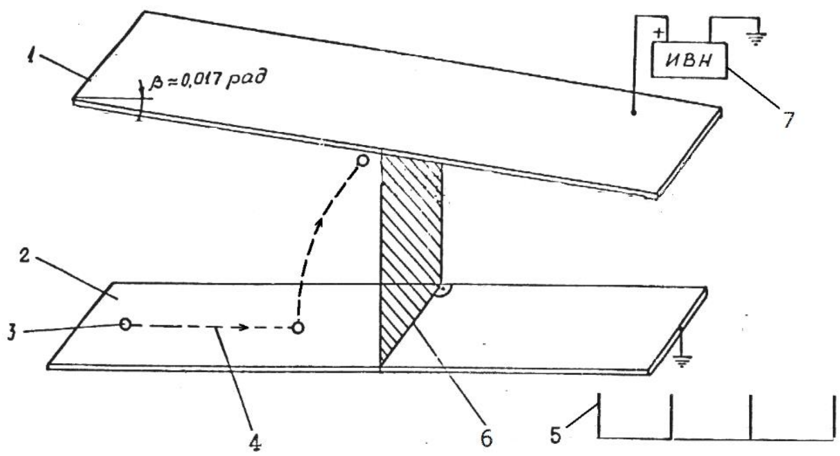

Figure 1. To explain the principle of sorting and purification of alfalfa seeds in an electric field with increasing intensity: 1- top electrode; 2- bottom electrode; 3- seed particle; 4- trajectory of particle movement in the interelectrode space; 5- separation fraction receivers; 6- vertical plane of constant electric field intensity; 7- high voltage source[8].

The main force exerted by the electric field and pulling the seed away from the lower electrode is determined by the following expression

$$F_э=EQ_{cn}(t), \quad (2)$$

where E is the electric field strength at the point where the seed is located; Q_{cn} (t) is the charge of the seed at time t.

Analysis of expression (2) shows that the course of the process of movement of the seed in the interelectrode space of the device depends on the amount and law of change of the charge acquired by the seed in the electrostatic space. Therefore, let us consider the dynamics of the change of the seed's charge during its movement in the interelectrode space[9].

When moving, the limit charge of the seed will increase linearly according to the expression

$$Q_{cn}(t)=\frac{\varepsilon_0 k_s}{d}E(t) \quad (3)$$

After reaching the limit charge, sufficient to break away from the lower electrode, it will fly up to the upper electrode. As applied to an electrostatic field with a uniformly increasing strength, we can write

$$E(t)=E_H+K_t t, \quad (4)$$

where E_n is the initial value of the field strength, V/m

K_t - coefficient of change in field strength per unit time, V/m*s

t - time, s.

The value of the coefficient K_t depends on the speed of seed movement, according to the expression:

$$K_t=\frac{E_k-E_H}{l}v_c \quad (5)$$

where E_k is the final value of the field strength, V/m;

E_n - initial value of field strength, V/m;

l - length of interelectrode space, m;

v_c - velocity of seed movement in the working space, m/s.

The differential equation for the dynamics of electric charge accumulation has the following form:

$$T_c\frac{dQ_c(t)}{dt}+Q_c(t)=k_{ct}k_t+k_{co}(E_H+k_t t) \quad (6)$$

where k_{ct} and k_{co} are coefficients that take into account the design parameters of the electrode system[10].

The solution of the differential equation by the method of uncertain coefficients will be:

$$Q_c(t)=Q_{CH}e^{-\frac{t}{T_c}}+(k_{co}E_H-k_t(T_c k_{co}-k_{ct}))(1-e^{-\frac{t}{T_c}})+k_{co}k_t t \quad (7)$$

The graphical dependence of expression (7) is shown in Fig. 2. The figure shows that the actual value of the charge value $Q_c(t)$ differs from the theoretical limit value of the charge value $Q_{cn}(t)$, the tension value ΔQ_c because of the finite velocity vc of the seed movement, as it was mentioned above. Consequently, ΔQ_c is proportional to the velocity v_c.

In the time interval limited within up to 5 T_c , the difference ΔQ_c between the actual charge value $Q_c(t)$ and its theoretical value $Q_{cn}(t)$ is significant and varies in magnitude over time $\Delta Q_c(t)$, and at T>5Tc with almost sufficient accuracy, we can assume that it has a constant value for a given speed v_c. In this case, the value from Fig. can be determined for $v_c \rightarrow 0$ and $t \rightarrow \infty$ according to and , whence:

$$Q_{cHn} = k_{co} E_H = \frac{\varepsilon_0 k_s}{d} E_H \,. \qquad (8)$$

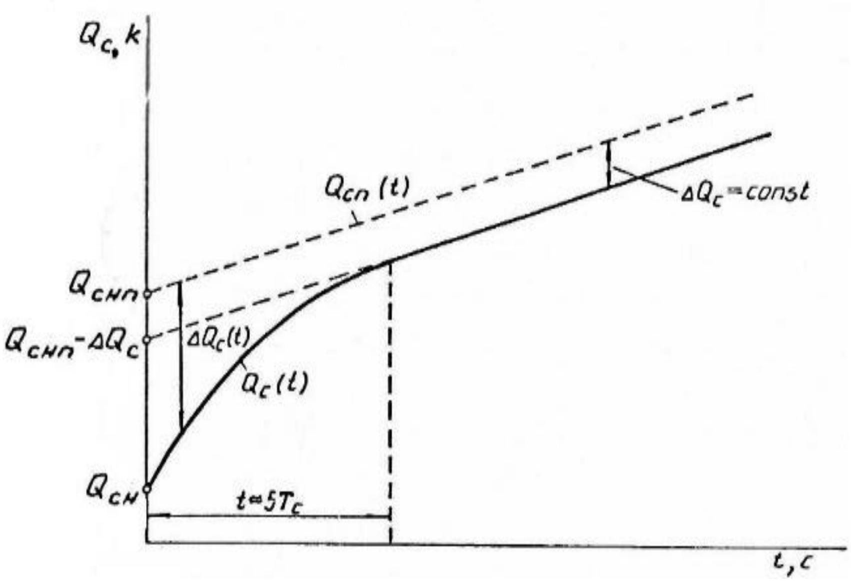

Figure 2. Change in the charge of a seed moving in an electrostatic field with a uniformly increasing intensity

For $Q_{cn}(t)$, according to (7) and (8), under the condition $v_c>0$ we obtain the dependence

$$Q_{cn}(t) = k_{co} E_H + k_{co} k_t t = \frac{\varepsilon_o k_s}{d} E_H + \frac{\varepsilon_o k_s (E_k - E_H)}{dl} v_c t \,. \qquad (8)$$

It follows from the above that the limiting charge value Q_{cn} and $Q_{cn}(t)$ do not depend on the material humidity (respectively εc and γc), since these expressions do not include the values that depend on the electrophysical properties of the seeds. This fact improves the accuracy of separation of alfalfa and aesoritic seeds.

1.Known technical means do not provide the required purity of alfalfa seeds due to their inherent disadvantages that do not take into account their morphological structure.

2. To increase the accuracy of cleaning, it is necessary to use a device with tapering flat electrodes that form a non-uniform electrostatic field, the strength of which increases linearly in the direction of seed movement.

3. Seed charge accumulation at t >5Tc is directly proportional to the way of seed movement, which will provide the selectivity of seed detachment from the lower electrode, increasing the clarity of their separation and purification by properties.

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