MODELING THE PROCESS OF AIR IONIZATION IN GRAIN PRODUCT STORAGE WAREHOUSES

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Аннотация

В статье представлены результаты исследования процесса ионизации крупногабаритных зданий, динамики движения ионов и сил, воздействующих на них. Учитывая полученные результаты для процессов хранения зерна, мы изучили процессы распределения ионов внутри здания. Согласно полученным результатам решена проблема размещения ионизаторов внутри здания.

Ключевые слова: Коронный разряд, ионизация, динамика ионов, скорость ионов, сильные электрические поля, критическая напряженность электрического поля, силы действующие на воздушные ионы, электрические ионизаторы, взаимное экранирование электрического поля, концентрация ионов.

Abstract

The article presents the results of studying the process of ionization of large-scale buildings, the dynamics of ion movement and the forces affecting them. Considering the obtained results for grain storage processes, we studied the processes of ion distribution inside the building. According to the obtained results, the problem of placing ionizers inside the building was solved.

Keywords: corona discharge, ionization, ion dynamics, ion velocity, strong electric fields, critical electric field strength, forces acting on air ions, electric ionizers, mutual screening of the electric field, ion concentration.

Introduction. Ensuring the economic stability of the country and its development are becoming an important issue on a global scale. As a result of the introduction and improvement of innovative technologies, the increase in the volume and quality of production is closely related to energy resources. Technologies, which were not available at all a few years ago, are now serving the overall GDP growth and development of states and also affecting the distribution in the labor market.

The results of a scientific study on the conservation of energy resources around the world and the effective use of energy equipment show that no matter how much the power generation capacity increases, it is impossible to meet the increasing demand by wasting it, but rather save electricity and effectively use energy equipment will pay off.

The high technical and economic requirements for the quality and efficiency of agricultural technological processes necessitate the need to solve the issue of ensuring the reliability of electrical equipment involved in agricultural production.

Research methodology. Crown discharge electric ionizers work based on the excitation and ionization of air-containing gases in an uneven electric field with sufficient electric field voltage on the surface of the electrodes of neutral molecules and atoms. The extreme unevenness of the electric field is achieved using two electrodes with different surface curvature. The first electrode is a sharp edge with a very small radius of surface curvature and is called a crown discharge electrode, while the second electrode is almost flat or has a very large radius of surface curvature that connects to the ground. Crown discharge electrodes can ionize air if they have sufficient potential.

In the storage of cereals in ionized air muxite, electromagnetic forces have a direct effect on living biological objects, and electricity acts directly without the conversion of another type of energy, so that the technological process is carried out with low energy consumption. The waste of products is brought to a minimum. Crown discharge air ionization devices can be used effectively in the grain storage process. They are cheap, the technology is simple, the operation is flexible and can be carried out in different options. The visually tightening of the discharge electrodes can be effectively applied in the grain storage process. In this case, the quality of ionization will not be high, ions will be unevenly distributed inside the building. For uniform air ionization in large buildings, it will be advisable to install ionizers in the ventilation system. In this case, the flow of ions is distributed evenly inside the building, even under the influence of ventilation forces, and not only electrostatic forces, it will be possible to perform quality processing on the product.

Results of research. As a result of research, the effectiveness of needle discharge electrodes was determined. Their installation density was recommended to be 150-474 PCs/m2. Here it is shown that the length of the needles depends on the distance between them. The distance between the needles, in turn, will depend on the length of the discharge distance.

With the issue of determining the constructive parameters of the needle Crown discharge electrodes and their placement, A.Raxmatov was engaged, who used ionization devices in air purification filters and ozonators [3,4]. Crown discharge has been shown to be effective in extracting air pollution, especially microsurgery with very small dimensions. The research used different current sources positive, negative, industrial frequency, pulse and increased frequency, taking a crown discharge in the current and determining the optimal parameters for each case.

We have developed a plan for our research based on the results of the above taxilies. Initially, we studied the technological features of long-term storage of cereals, the processes that go through the storage period in cereals, the sources of product wastes, the effect of air ions on cereals and the optimal air ionization modes, the main parameters of the electric Crown discharge ionizer device, which provides these modes. We checked the results of our experimental and theoretical studies obtained directly in the conditions of production.

When large fields are ionized, the product being processed is at a distance from the electric ionizer. In order to obtain a high efficiency in the process of processing products, it is necessary that the ions fully reach the product. Here, air ions pass through three different characteristic zones: the ionization zone, the scattering area of volumetric ions and the zone of ionization of the surface of the processed product. In the ionization zone, under the action of a high-voltage Crown discharge electric field, air molecules, corresponding to the voltage of the discharge electrodes, receive a certain charge. In this zone, the dynamics of the movement of ions changes under the influence of several forces and becomes extremely non-volatile. In the ionization zone, ions are mainly affected by an electric field. An electric wind, directed along the electric field lines of force, occurs, which carries ions out of the ionization zone [5]. The strength of the electric field and the amount of charge of the particle determine the magnitude of the electric force acting on the ions and will look like this, this force is also called Kulon force:

$$F_k = E \cdot q \qquad (1)$$

Again the ion is influenced by its own weight force:

$$F_q = mg \qquad (2)$$

Due to the uneven distribution of ions in volume, the effect of an electric field with an electric field voltage of E volumetric charges on a charged particle with dielectric absorption is as follows:

$$F_E = 2\ \tau\varepsilon_0 a^2 \frac{\text{c}-1}{\text{c}+2}\ \text{град}\ \text{E}^2 \qquad (3)$$

In order to improve the quality of ionization of room air, it was recommended that the process of air ionization of the grain storage tank be carried out in conjunction with the ventilation process. The intensity of ionization and the dynamics of the propagation of ions in a closed building will depend on the voltage of the discharge electrodes and the speed of air flow. As a result of the research, when developing ionizers for grain storage warehouses, issues of optimal constructive size indicators of the system of discharge electrodes of the device and their placement indoors were identified.

As a result of analytical calculations and experimental research, we come to the following conclusions. The reason for the use of ionization in various technological processes by means of an air Crown discharge lies in the cheapness and simplicity of the method, low energy demand and universality of control. Air ionization mode magnitudes will depend on the ionizer constancy and the properties of the current source. When the crown discharge electric field indicators are determined analytically and experimentally, the result error does not exceed 3÷5%. Outside the discharge field, the concentration of volumetric ions is 10^{14} ion/m^3 when the charge density is 10^{-6}k/m^3[6].

When ionizers are placed within a building at a distance of 2 to 2.5 meters from each other and the ionization process is carried out in conjunction with the ventilation process, the unevenness of the distribution of ions in the room decreases and is around 85-87%.

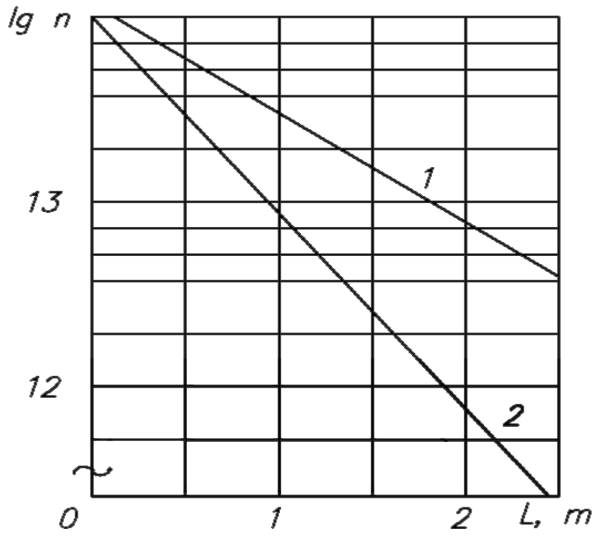

Figure 1. Ion scattering graph in a closed building: L-distance from ionizer to control point, m; volumetric concentration of n-ions, ion/m3.

Conclusions:

1. In buildings, air ions pass through three different characteristic zones, until they go from the ionizer to the special ionization zone, the scattering area of volumetric ions and the zone of ionization of the surface of the processed product. The parameters of these zones differ dramatically from each other, and each will have to be studied separately.

2. In the process of ionization, the air ions are affected by the voltage of the electric field of the crown discharge, the ion's own weight force, the electric field voltage of the volumetric charges generated by the ionizer, the resistance force of the medium and the electric field forces of the ion layer formed on the surface of the product.

3. As a result of studying the dynamics of ion scattering, it will be possible to determine the optimal operating modes of the ionizer based on the requirements of the grain storage ionization technology.

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